

# INTERNATIONAL STANDARD



**Safety requirements for electrical equipment for measurement, control  
and laboratory use –**

**Part 2-032: Particular requirements for HAND-HELD and hand-manipulated current  
sensors for electrical test and measurement**



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**Safety requirements for electrical equipment for measurement, control  
and laboratory use –  
Part 2-032: Particular requirements for HAND-HELD and hand-manipulated current  
sensors for electrical test and measurement**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

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### **SAFETY REQUIREMENTS FOR ELECTRICAL EQUIPMENT FOR MEASUREMENT, CONTROL, AND LABORATORY USE –**

#### **Part 2-032: Particular requirements for HAND-HELD and hand-manipulated current sensors for electrical test and measurement**

### FOREWORD

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**This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.**

International Standard IEC 61010-2-032 has been prepared by IEC technical committee 66: Safety of measuring, control and laboratory equipment.

This fourth edition cancels and replaces the third edition published in 2012. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) It has been indicated that current sensors used as FIXED EQUIPMENT are not within the scope of this document.
- b) Fork-style current sensors have been added.
- c) Requirements from Part 2-033 applicable to CLAMP MULTIMETERS that have a primary purpose of measuring voltage on live MAINS have been included in the new normative Annex EE.
- d) CLEARANCES and CREEPAGE DISTANCES for measuring circuit TERMINALS exceeding 1 000 V a.c. or 1 414 V d.c. and for WET LOCATIONS have been specified.
- e) Reduced CREEPAGE DISTANCES are allowed to be according to material group I for all insulating materials.
- f) Requirements for input/output circuits of Type A, Type B and Type C current sensors have been detailed in 6.9.102.
- g) Requirements for output circuit leads have been modified.
- h) The JAW impact test has been limited to the front of the JAWS.
- i) The abrasion test for cords of flexible current sensors has been removed and replaced by a pressure test at high temperature.
- j) The voltage source for testing overvoltage limiting components or circuits may be limited to 400 V.
- k) Reference to IEC 61010-031 for probe assemblies has been added.
- l) Requirements for the prevention of TRANSIENT OVERVOLTAGES for MAINS voltage measuring circuits have been added.
- m) Requirements for measuring circuits from 1 000 V to 3 000 V have been added.
- n) An informative Annex CC about the dimensions of banana TERMINALS has been added.
- o) A flowchart for insulation according to the type of circuit has been added in a new Annex DD.

The text of this International Standard is based on the following documents:

| FDIS        | Report on voting |
|-------------|------------------|
| 66/691/FDIS | 66/695/RVD       |

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of the IEC 61010 series, under the general title *Safety requirements for electrical equipment for measurement, control, and laboratory use*, can be found on the IEC website.

This Part 2-032 is to be used in conjunction with the latest edition of IEC 61010-1. It was established on the basis of the third edition (2010) of IEC 61010-1 and its Amendment 1 (2016), hereinafter referred to as Part 1.

This Part 2-032 supplements or modifies the corresponding clauses in IEC 61010-1 so as to convert that publication into the IEC standard: *Particular requirements for HAND-HELD and hand-manipulated current sensors for electrical test and measurement*.

Where a particular subclause of Part 1 is not mentioned in this Part 2-032, that subclause applies as far as is reasonable. Where this Part 2-032 states "addition", "modification", "replacement", or "deletion" the relevant requirement, test specification or note in Part 1 should be adapted accordingly.

In this standard:

- a) the following print types are used:
  - requirements: in roman type;
  - NOTES: in small roman type;
  - *conformity and tests: in italic type*;
  - terms used throughout this standard which have been defined in Clause 3: SMALL ROMAN CAPITALS;
- b) subclauses, figures, tables and notes which are additional to those in Part 1 are numbered starting from 101. Additional annexes are lettered starting from AA and additional list items are lettered from aa).

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

**IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.**

The contents of the corrigendum of February 2020 have been included in this copy.

## INTRODUCTION

~~IEC 61010-1 specifies the safety requirements that are generally applicable to all equipment within its scope. For certain types of equipment, the requirements of IEC 61010-1 will be supplemented or modified by the special requirements of one, or more than one, particular part 2s of the standard which are to be read in conjunction with the Part 1 requirements.~~

~~This Part 2-032 specifies the safety requirements that are generally applicable to HAND-HELD and hand-manipulated current sensors (see Clause 1).~~

~~Part 2-030 specifies the safety requirements for testing and measuring circuits which are connected for test or measurement purposes to devices or circuits outside the measurement equipment itself.~~

~~Part 2-033 specifies the safety requirements for handheld METERS that have a primary purpose of measuring voltage on a live MAINS CIRCUIT.~~

~~Except for protective bonding, all requirements of Part 2-030 have been included into Part 2-032. Equipment within the scopes of Part 2-030 and Part 2-032 are considered to be covered by the requirements of Part 2-032. However, For equipment within the scope of both Part 2-032 and Part 2-033, the two standards are to be read in conjunction.~~

Part 2-030 specifies the safety requirements for equipment with testing and measuring circuits which are connected for test or measurement purposes to devices or circuits outside the measurement equipment itself. Requirements of Part 2-030 have been included in this Part 2-032. Equipment within the scopes of both Part 2-030 and Part 2-032 are considered to be covered by the requirements of this Part 2-032.

Part 2-033 specifies the safety requirements for hand-held multimeters that have the primary purpose of measuring voltage on live MAINS. For equipment within the scope of Part 2-032 and Part 2-033, only this Part 2-032 is applicable.

Part 2-034 specifies the safety requirements for measurement equipment for insulation resistance and test equipment for electric strength which are connected to units, lines or circuits for test or measurement purposes. For equipment within the scope of Part 2-032 and Part 2-034, both documents should be read in conjunction.

## SAFETY REQUIREMENTS FOR ELECTRICAL EQUIPMENT FOR MEASUREMENT, CONTROL, AND LABORATORY USE –

### Part 2-032: Particular requirements for HAND-HELD and hand-manipulated current sensors for electrical test and measurement

#### 1 Scope and object

This clause of Part 1 is applicable except as follows:

##### 1.1.1 Equipment included in scope

*Replace the existing text with the following:*

This part of IEC 61010 specifies safety requirements for HAND-HELD and hand-manipulated current sensors described below.

These current sensors are for measuring, detecting or injecting current, or indicating current waveforms on circuits without physically opening the current path of the circuit being measured. They ~~may~~ can be stand-alone current sensors or accessories to other equipment or parts of combined equipment (see Figure 101). These include measurement circuits which are part of electrical test and measurement equipment, laboratory equipment, or process control equipment. ~~The existence of~~ These current sensors and circuits ~~in equipment requires~~ need additional protective means between the current sensor, the circuit and an OPERATOR.

~~NOTE 1 This part includes also the requirements of Part 2-030. Testing and measuring circuits that are not within the scope of this part are considered to be covered by the requirements of Part 1 or other parts 2s of IEC 61010, and then will also need to meet the requirements of these other parts with the exception of Part 2-030. Current clamp meters and similar currents sensors that have a primary purpose of measuring voltage on a live MAINS CIRCUIT are also within the scope of Part 2-033.~~

NOTE 1 Combined equipment is equipment that is electrically connected to a current sensor by means of a permanent connection which can be detached only by the use of a TOOL.

NOTE 2 Some current sensors are also known as current clamps, CLAMP MULTIMETERS and current probes.

Current sensors ~~require hand manipulation~~ are hand-manipulated before and/or after a test or measurement, but do not necessarily need to be HAND-HELD during the test or measurement. Current sensors used as FIXED EQUIPMENT are not within the scope of this document.

~~NOTE 3 Some current sensors designed for portable use can also be used for fixed installations.~~

The following types of current sensors are covered:

- a) Type A: a current sensor designed to be applied ~~around to~~ or removed from ~~UNINSULATED~~ HAZARDOUS LIVE UNINSULATED CONDUCTORS. Type A current sensors have defined HAND-HELD or hand-manipulated parts providing protection against electric shock from the conductor being measured, and also have protection against short-circuits between wires and ~~between~~ busbars during clamping.
- b) Type B: a current sensor which has protection against short-circuits between wires or busbars during clamping but without defined HAND-HELD or hand-manipulated parts which provide protection against electric shock during clamping. Additional protective means are necessary to avoid electric shock from HAZARDOUS LIVE conductors which cannot be de-energised during application or removal of the current sensor.

EXAMPLE 1 Flexible current sensors.

- c) Type C: a current sensor without protection against short-circuits between wires or busbars during clamping. Type C current sensors are intended to be applied to or removed from ~~UNINSULATED~~ HAZARDOUS LIVE UNINSULATED CONDUCTORS or from non-limited-energy circuit conductors only when they are de-energised.

EXAMPLE 2 Split-core transducers.

- d) Type D: a current sensor designed to be applied ~~around~~ to or removed from insulated conductors or from limited-energy circuit conductors.

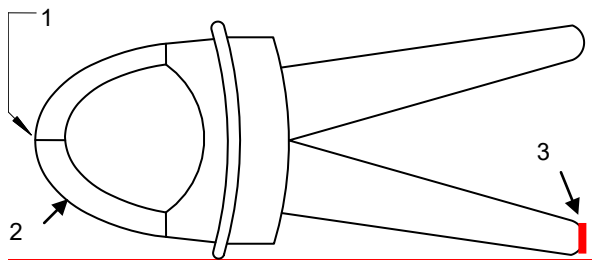
~~A Type D current sensor does not need protection against short-circuits during clamping and has no defined HAND-HELD or hand-manipulated parts providing protection against electric shock from the conductor being measured.~~

EXAMPLE 3 Current probes for oscilloscopes and earth leakage current detectors.

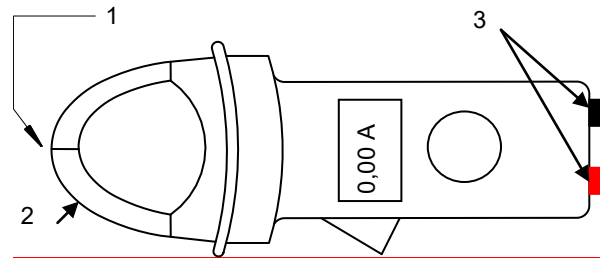
~~NOTE 4~~ All current sensors can also be used ~~around~~ with insulated conductors. In this case, HAZARDS are limited to acceptable levels by the insulation of the conductors.

Additional requirements for CLAMP MULTIMETERS are given in Annex EE.

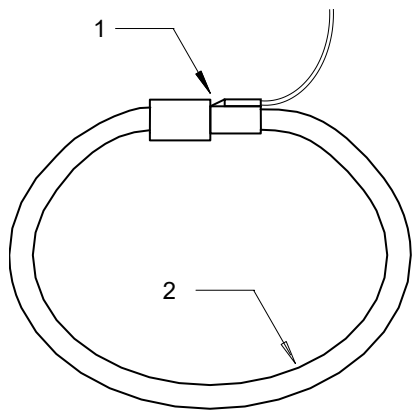
Figure 101 shows graphical representations of typical current sensors for illustration purposes. Current sensors can look different depending on the design.



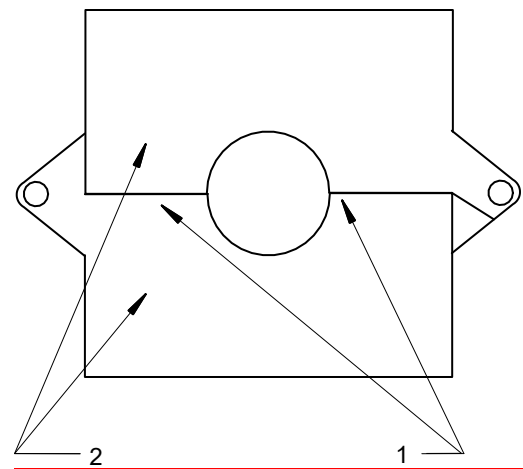
**Type A**  
Current sensor as an accessory



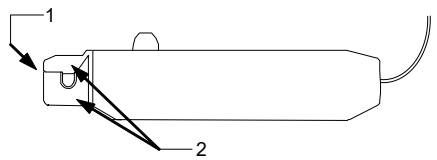
**Type A**  
Current sensor with self-contained measuring functions  
or with additional measuring functions



**Type B**  
Flexible current sensor



**Type C**  
Split-core current sensor



**Type D**  
Current sensor for non HAZARDOUS LIVE applications  
(shown with a sliding JAW)

IEC 1865/12

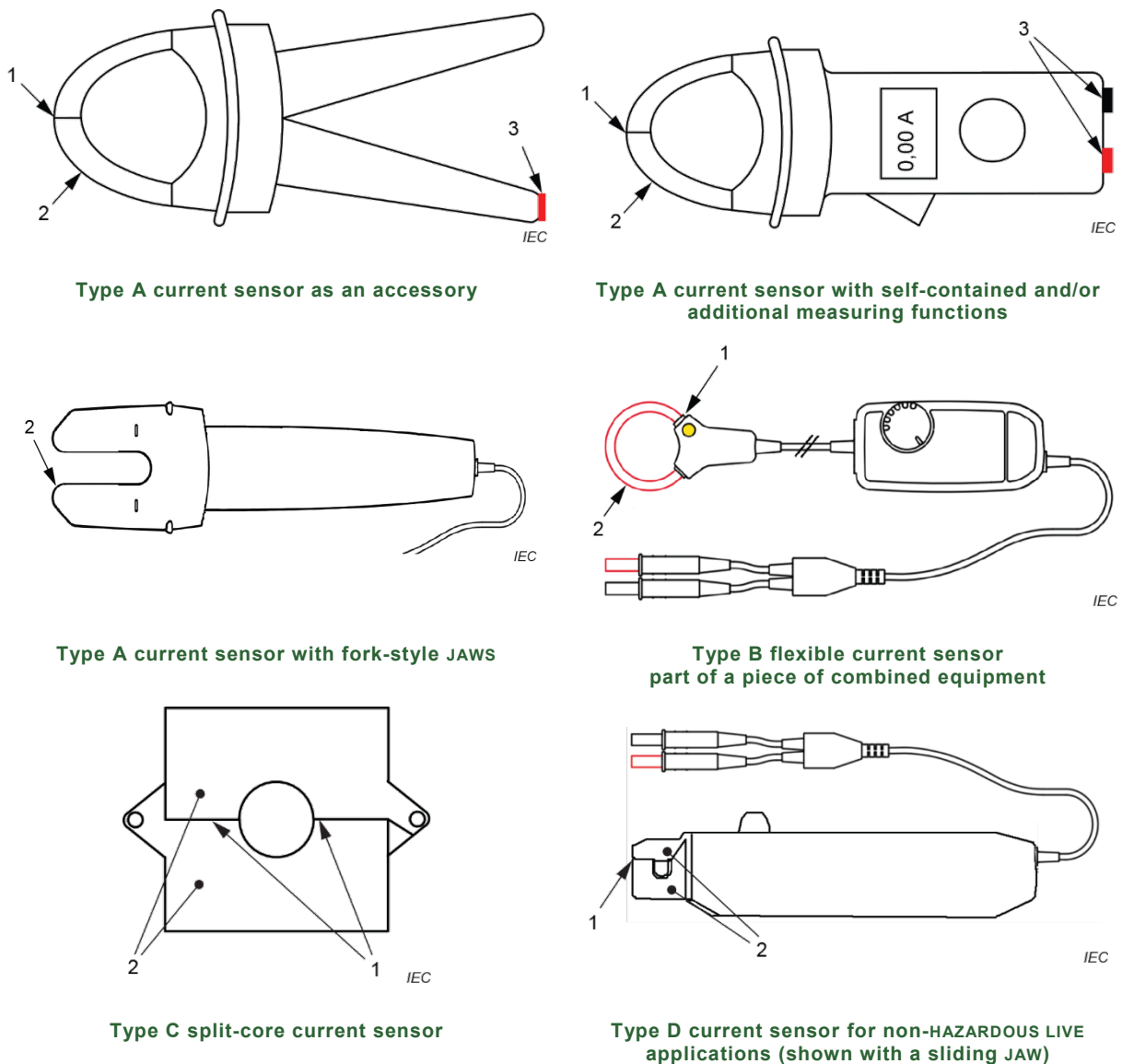


**Figure 101 – Examples of current sensors and their parts**

### 1.2.1 Aspects included in scope

Add the following ~~two~~ **three** new paragraphs at the end of the subclause:

Requirements for protection against HAZARDS resulting from NORMAL USE and REASONABLY FORESEEABLE MISUSE of measuring circuits are given in Clause 101.

Requirements for prevention of HAZARD from arc flash and short-circuits are given in Clause 102.

Requirements for reliance on the displayed value of CLAMP MULTIMETERS are given in Clause EE.5 .

## 2 Normative references

This clause of Part 1 is applicable except as follows:

*Replace "IEC 61010-031" with the following new reference:*

IEC 61010-031:2015, *Safety requirements for electrical equipment for measurement, control and laboratory use – Part 031: Safety requirements for hand-held and hand-manipulated probe assemblies for electrical test and measurement*  
IEC 61010-031:2015/AMD1:2018

*Replace "IEC 61180-1 (all parts)", "IEC 61180-1" and "IEC 61180-2", with the following new reference:*

IEC 61180, *High-voltage test techniques for low-voltage equipment – Definitions, test and procedure requirements, test equipment*

## 3 Terms and definitions

This clause of Part 1 is applicable except as follows:

### 3.1 Equipment and states of equipment

*Add the following two new terms and definitions:*

#### 3.1.101

##### **HAND-HELD**

intended to be supported by one hand during NORMAL USE

#### 3.1.102

##### **CLAMP MULTIMETER**

HAND-HELD multi-range and multifunction measuring instrument intended to measure current on a live MAINS without physically opening the conductors, voltage on a live MAINS and other electrical quantities such as resistance

### 3.2 Parts and accessories

*Add the following two new terms and definitions:*

#### 3.2.101

##### **JAW**

part of a current sensor which surrounds or partially surrounds the conductor under test

#### 3.2.102

##### **JAW END**

part of the JAW where opening occurs while clamping around a conductor

### 3.5 Safety terms

*Replace the definitions of 3.5.4 and 3.5.5 with the following new definitions:*

#### 3.5.4

##### **MAINS**

~~low-voltage electricity supply system to which the current sensor concerned is designed to be connected for the purpose of powering the current sensor or for measurements~~  
electricity supply system

**3.5.5****MAINS CIRCUIT**

~~circuit which is intended to be directly connected to the MAINS for the purpose of powering the current sensor or for measurements~~

Add the following new term and definition:

**3.5.101****MEASUREMENT CATEGORY**

classification of testing and measuring circuits according to the type of MAINS ~~CIRCUITS~~ to which they are intended to be connected

Note 1 to entry: MEASUREMENT CATEGORIES take into account OVERVOLTAGE CATEGORIES, short-circuit current levels, the location in the building installation ~~at which~~ where the test or measurement is to be made and some forms of energy limitation or transient protection included in the building installation. See Annex AA for more information.

**3.6 Insulation**

Add the following new term and definition:

**3.6.101****UNINSULATED CONDUCTOR**

conductor not insulated by solid insulation or insulated by solid insulation which does not meet the requirements for BASIC INSULATION for the relevant voltage to earth

**4 Tests**

This clause of Part 1 is applicable except as follows:

**4.3.2.5 MAINS supply**

Replace the existing title and text with:

**4.3.2.5 Power supply**

The following requirements apply.

- a) The MAINS supply voltage shall be between 90 % and 110 % of any RATED supply voltage for which the equipment can be set or, if the equipment is RATED for a greater fluctuation, at any supply voltage within the fluctuation range.
- b) The MAINS frequency shall be any RATED frequency.
- c) Equipment for both a.c. and d.c. shall be connected to an a.c. or d.c. supply.
- d) Equipment powered by single-phase a.c. MAINS supply shall be connected both with normal and reverse polarity.
- e) If the means of connection permit reversal, battery-operated and d.c. equipment shall be connected with both reverse and normal polarity.

**4.3.2.6 Input and output voltages**

Replace the existing title and text with:

**4.3.2.6 Input and output voltages or currents**

Input and output voltages or currents, including floating voltages but excluding the MAINS supply voltage, shall be set to any voltage or current within their RATED range, in normal and reverse polarity if possible.

#### 4.4.2.8 Outputs

Replace the text with the following:

Outputs shall be open-circuited and short-circuited, one at a time.

## 5 Marking and documentation

This clause of Part 1 is applicable except as follows:

### 5.1.2 Identification

Add the following new items and a new paragraph after the note to item b):

- aa) for current sensors designed for use only with a specific model of equipment, a clear identification of the equipment, or with symbol 14 of Table 1 if this information is available only in the documentation;
- bb) for Type A current sensors, with symbol 102 of Table 1;
- cc) for Type B and Type C current sensors, with symbol 101 of Table 1;
- dd) for Type D current sensors, with symbol 101 and symbol 14 of Table 1 ~~is permitted with an additional marking (see 5.1.5.102).~~

The relevant symbol (14, 101 or 102) shall be marked adjacent to the JAWS or to the marking of the MEASUREMENT CATEGORY for the JAWS, if present (see 5.1.5.101 and 5.1.5.102).

**Table 1 – Symbols**

Add the following *two* new symbols:

| Number | Symbol                                                                              | Reference                | Description                                                                                                                                                                                |
|--------|-------------------------------------------------------------------------------------|--------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 101    |  |                          | Do not apply <del>around</del> current sensor to or remove from <del>UNINSULATED</del> HAZARDOUS LIVE UNINSULATED CONDUCTORS, which may render electric shock, electric burn, or arc flash |
| 102    |  | IEC 60417-6300 (2016-03) | Application <del>around</del> of current sensor to and removal from <del>UNINSULATED</del> HAZARDOUS LIVE UNINSULATED CONDUCTORS is permitted                                              |

### 5.1.5 TERMINALS, connections and operating devices

Add the following *two* new subclauses:

#### 5.1.5.101 Measuring circuit TERMINALS

##### 5.1.5.101.1 General

Except as permitted in 5.1.5.101.4:

- a) the value of the RATED voltage to earth of measuring circuit TERMINALS shall be marked, and
- b) the value of the RATED voltage or the RATED current, as applicable, of each pair or set of measuring circuit TERMINALS that are intended to be used together shall be marked, and

- c) the pertinent MEASUREMENT CATEGORY for each individual, pair, or set of measuring circuit TERMINALS, or symbol 14 of Table 1 shall be marked as specified in 5.1.5.101.2 and 5.1.5.101.3, if applicable.

Measuring circuit TERMINALS are usually arranged in pairs or sets. Each pair or set of TERMINALS may have a RATED voltage or a RATED current, or both, within that set, and each individual TERMINAL may have a RATED voltage to earth. For some ~~equipment~~ current sensors, the RATED voltage between TERMINALS may be different from the RATED voltage to earth. Markings shall be clear to avoid misunderstanding.

Markings shall be placed adjacent to the TERMINALS. However, if there is insufficient space (as in multi-input ~~equipment~~ current sensors), the marking may be on the RATING plate or scale plate, or the TERMINAL may be marked with symbol 14 of Table 1.

For any set of measuring circuit TERMINALS, symbol 14 of Table 1 does not need to be marked more than once, if it is close to the TERMINALS.

*Conformity is checked by inspection and, if applicable, as specified in 5.1.5.101.2 and 5.1.5.101.3, taking the exceptions in 5.1.5.101.4 into account.*

#### **5.1.5.101.2 Measuring circuit TERMINALS rated for MEASUREMENT CATEGORIES ~~II, III or IV~~**

The relevant MEASUREMENT CATEGORY shall be marked for TERMINALS of measuring ~~circuit~~ ~~TERMINALS~~ circuits RATED for ~~measurements within~~ MEASUREMENT CATEGORIES ~~II, III or IV~~. The MEASUREMENT CATEGORY markings shall be "CAT II", "CAT III" or "CAT IV" as applicable.

Marking those TERMINALS with more than one type of MEASUREMENT CATEGORY and its RATED voltage to earth is permissible ~~(see also 5.1.5.101.1)~~.

*Conformity is checked by inspection.*

#### **5.1.5.101.3 Measuring circuit TERMINALS RATED for connection to voltages above the levels of 6.3.1**

Symbol 14 of Table 1 shall be marked for measuring circuit TERMINALS RATED for connection to voltages above the levels of 6.3.1, but that are not RATED for ~~measurements within~~ MEASUREMENT CATEGORIES ~~II, III or IV~~ (see also 5.4.2 bb)).

*Conformity is checked by inspection.*

#### **5.1.5.101.4 ~~Low voltage, permanently connected, or dedicated measuring circuit~~ ~~TERMINALS~~ Measuring circuit TERMINALS which are permanently connected, dedicated or for non-HAZARDOUS LIVE voltages**

Measuring circuit TERMINALS do not need to be marked if:

- they are intended to be permanently connected and not ACCESSIBLE (see 5.4.3 aa) and bb)), or
- they are dedicated only for connection to specific TERMINALS of other equipment (see also 6.101.3), or
- it is obvious from other indications that the RATED voltage is below the levels of 6.3.1.

NOTE Examples of acceptable indications that the inputs are intended to be less than the levels of 6.3.1 include:

- the full scale deflection marking of a single-range indicating voltmeter or ammeter;
- the maximum range marking of a voltage selector switch;
- a marked voltage or power RATING expressed in dB, mW or W, where the equivalent value, as explained in the documentation, is below ~~33~~ 30 V a.c.

*Conformity is checked by inspection.*

#### 5.1.5.102 Voltage and current RATINGS of JAWS

Current sensors that are intended to be used on UNINSULATED CONDUCTORS shall be marked with the value of the RATED voltage to earth of the JAWS.

~~Current sensors that are intended to be used only on insulated conductors shall be marked to indicate that the current sensor must not be used on UNINSULATED conductors, or with symbol 14.~~

JAWS of Type A, Type B or Type C current sensors RATED for ~~measurements within MEASUREMENT CATEGORIES II, III or IV~~, shall be marked with the relevant MEASUREMENT CATEGORY adjacent to the voltage to earth marking. The MEASUREMENT CATEGORY markings shall be "CAT II", "CAT III" or "CAT IV" as applicable.

JAWS and output circuit TERMINALS of Type D current sensors shall not be marked with any MEASUREMENT CATEGORY.

The value of the RATED current shall be marked on or close to the JAWS. The nature of the current shall also be marked unless the marked value applies to both a.c. and d.c. ~~current~~.

*Conformity is checked by inspection.*

#### 5.4.1 General

*Add the following new items to the list and a new paragraph:*

- aa) information about each relevant MEASUREMENT CATEGORY if the measuring circuit is RATED for MEASUREMENT CATEGORIES (see 5.1.5.101.2);
- bb) for measuring circuits that are not RATED for MEASUREMENT CATEGORIES, but that could be misused by connection to such circuits, a warning not to use the current sensor for measurements on MAINS, and a detailed RATING including TRANSIENT OVERVOLTAGES (see AA.2.4 for more information).

Some current sensors may have multiple MEASUREMENT CATEGORY RATINGS for the same measuring circuit. For such current sensors, the documentation shall clearly identify the MEASUREMENT CATEGORIES where the current sensor is intended to be used and where it shall not be used.

#### 5.4.2 Equipment RATINGS

*Add the following two new items to the list and a new paragraph:*

- aa) information about each relevant MEASUREMENT CATEGORY if the measuring circuit ~~has a RATING~~ is RATED for MEASUREMENT ~~CATEGORY II, III or IV~~ CATEGORIES (see 5.1.5.101.2 and 5.1.5.102);
- bb) for Type A, Type B and Type C current sensors that ~~do not have a RATING~~ are not RATED for MEASUREMENT ~~CATEGORY II, III or IV~~ CATEGORIES, but that could be misused by connection to such circuits, a warning not to use the current sensor for measurements on MAINS ~~CIRCUITS~~, and a detailed RATING including TRANSIENT OVERVOLTAGES (see AA.2.4 for more information).

If the current sensor has multiple MEASUREMENT CATEGORY RATINGS for the same measuring circuit, the documentation shall clearly identify the MEASUREMENT CATEGORIES where the current sensor is intended to be used and where it ~~must~~ shall not be used.

### 5.4.3 Equipment installation

*Add the following two new items to the list:*

- aa) for measuring circuit TERMINALS intended for permanent connection and ~~that are~~ RATED for MEASUREMENT CATEGORIES ~~II, III or IV~~, information regarding the MEASUREMENT CATEGORY, RATED voltages or RATED currents as applicable (see 5.1.5.101.2 and 5.1.5.102);
- bb) for measuring circuit TERMINALS intended for permanent connection and that are not RATED for MEASUREMENT CATEGORIES ~~II, III or IV~~, information regarding the RATED voltages, RATED currents, and RATED TRANSIENT OVERVOLTAGES as applicable (see 5.1.5.101.4 and 5.1.5.102).

### 5.4.4 Equipment operation

*Replace the existing text with the following:*

Instructions for use shall include, if applicable:

- a) identification and description of operating controls and their use in all operating modes;
- b) for current sensors designed for use only with a specific model of equipment, a clear identification of the equipment;
- c) specifications of limits for intermittent operation;
- d) specifications of limits of the current versus the frequency if the magnetic circuit can reach a hazardous temperature;
- e) explanations of symbols related to safety which are used on the ~~equipment~~ current sensor;
- f) instructions for interconnection to accessories and other equipment, including indication of suitable accessories and detachable parts;
- g) instructions for replacement of consumable materials;
- h) instructions for cleaning and decontamination;
- i) instructions for the application and removal of the current sensor;
- j) instructions to de-energise the installation on which the current is measured, or to adopt safe operating procedures when working on HAZARDOUS LIVE installations, during application and removal of Type B current sensors;
- k) instructions to de-energise the installation on which the current is measured, when working on HAZARDOUS LIVE installations, or non-limited-energy installations during application and removal of Type C current sensors;
- l) instructions about the function of the ~~tactile indicator or~~ PROTECTIVE BARRIER, indicating the limit of safe access of the HAND-HELD part;
- m) a warning to the OPERATOR that Type D current sensors are only for use around insulated conductors or limited energy circuit conductors;
- n) a warning to the OPERATOR that individual protective equipment should be used if HAZARDOUS LIVE parts in the installation where measurement is to be carried out could be ACCESSIBLE;
- o) a warning to the OPERATOR not to use a flexible current sensor if the wear indicator of the flexible cord used for the JAW of the flexible current sensor is visible (see ~~6.9.101.4~~ 8.103);
- p) a warning to the OPERATOR not to use a current sensor if the wear indicator in the JAW END is visible (see ~~6.9.101.3~~ 8.104);

- q) a warning to the OPERATOR not to use a current sensor above its RATED frequency, if the magnetic circuit can reach a hazardous temperature (see 10.101).

There shall be a statement in the instructions that, if the current sensor is used in a manner not specified by the manufacturer, the protection provided by the current sensor may be impaired.

*Conformity is checked by inspection.*

## 6 Protection against electric shock

This clause of Part 1 is applicable except as follows:

### 6.1.2 Exceptions

*Add the following new item ~~aa)~~ to the list:*

- aa) conductive parts of a JAW END, provided that they meet the requirements of 6.9.101.

### 6.5.2 PROTECTIVE BONDING

*Replace the existing title with the following and delete the text ~~with:~~*

### 6.5.2 ~~(Void)~~ Not used

## 6.6 Connections to external circuits

*Add the following ~~two~~ new subclauses:*

### 6.6.101 Measuring circuit TERMINALS

The conductive parts of each unmated measuring circuit TERMINAL which could become HAZARDOUS LIVE when the highest RATED voltage is applied to other measuring circuit TERMINALS on the ~~equipment~~ current sensor shall be separated by at least:

- a) for TERMINALS with voltage RATING up to 1 000 V a.c. or 1 500 V d.c., the applicable CLEARANCE and CREEPAGE DISTANCE of Table 101 from the closest approach of the test finger touching the external parts of the TERMINAL in the least favourable position (see Figure 1);
- b) for TERMINALS with voltage RATING exceeding 1 000 V a.c. or 1 500 V d.c., 2,8 mm for the CLEARANCE and CREEPAGE DISTANCE from the closest approach of the test finger touching the external parts of the TERMINAL in the least favourable position. These TERMINALS shall also withstand the voltage test of 6.8 with a test voltage equal to the RATED voltage of the TERMINAL multiplied by 1,25 applied between the closest approach of the test finger touching the external parts of the TERMINAL in the least favourable position and the other measuring circuit TERMINALS.

EXAMPLE For a 4 000 V a.c. r.m.s. RATED voltage, the test voltage is 5 000 V a.c. r.m.s. (7 070 V peak). The calculated CLEARANCE is 13,1 mm according to  $D_2$  in Table K.15. For homogeneous fields, a lower CLEARANCE value can be achieved by testing (see IEC 60664-1 for more information about homogeneous fields).

- c) for WET LOCATIONS, there are no CLEARANCE and CREEPAGE DISTANCE requirements for voltages between 16 V a.c. r.m.s. and 30 V a.c. r.m.s., or between 35 V d.c. and 60 V d.c., but conductive parts of unmated measuring circuit TERMINALS shall not be ACCESSIBLE.

**Table 101 – CLEARANCES and CREEPAGE DISTANCES for measuring circuit TERMINALS with HAZARDOUS LIVE conductive parts up to 1 000 V a.c. or 1 500 V d.c.**

| Voltage on conductive parts of TERMINAL                                                                                                                                                                                                                                                                                                                                      |                     | CLEARANCE and CREEPAGE DISTANCE |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|---------------------------------|
| V a.c. r.m.s.                                                                                                                                                                                                                                                                                                                                                                | V d.c.              | mm                              |
| $\geq 33 \leq 300$                                                                                                                                                                                                                                                                                                                                                           | $\geq 70 \leq 414$  | 0,8                             |
| $> 300 \leq 600$                                                                                                                                                                                                                                                                                                                                                             | $> 414 \leq 848$    | 1,0                             |
| $> 600 \leq 1\,000$                                                                                                                                                                                                                                                                                                                                                          | $> 848 \leq 1\,414$ | 2,6                             |
| NOTE For WET LOCATIONS, there are no CLEARANCE and CREEPAGE DISTANCE requirements for voltages between 16 V a.c. r.m.s. and 33 V a.c. r.m.s., or between 35 V d.c. and 70 V d.c., but conductive parts of unmated measuring circuit TERMINALS shall not be ACCESSIBLE. The values in this table are not applicable to voltages below HAZARDOUS LIVE voltages (see 6.3.1 a)). |                     |                                 |

| Voltage on conductive parts of TERMINAL                                                                    | CLEARANCE and CREEPAGE DISTANCE |
|------------------------------------------------------------------------------------------------------------|---------------------------------|
| V a.c. r.m.s. and V d.c.                                                                                   | mm                              |
| $\geq 30 \leq 300$                                                                                         | 0,8                             |
| $> 300 \leq 600$                                                                                           | 1,0                             |
| $> 600 \leq 1\,000$                                                                                        | 2,6                             |
| $> 1\,000 \leq 1\,500^a$                                                                                   | 2,8                             |
| NOTE The values in this table are not applicable to voltages below HAZARDOUS LIVE voltages (see 6.3.1 a)). |                                 |
| <sup>a</sup> Only for d.c. voltage.                                                                        |                                 |

Annex CC provides information regarding the recommended dimensions of 4 mm "banana" TERMINALS.

Conformity is checked by inspection ~~and~~, by the determination of ACCESSIBLE parts, by measurement of the applicable CLEARANCES and CREEPAGE DISTANCES, and if applicable, by the voltage test of 6.8.

#### 6.6.102 Specialized measuring circuit TERMINALS

Components, sensors, and devices intended to be connected to specialized measuring circuit TERMINALS shall not be both ACCESSIBLE and HAZARDOUS LIVE, in either NORMAL CONDITION or in SINGLE-FAULT CONDITION, even when the highest RATED voltage is applied to any other measuring circuit TERMINAL.

NOTE These specialized TERMINALS include, but are not limited to, TERMINALS for semiconductor measuring functions, capacitance measurements, and thermocouple sockets.

Conformity is checked by inspection and measurement. Components, sensors, and devices intended to be connected to specialized measuring circuit TERMINALS are connected. The measurements of 6.3 are made to establish that the levels of 6.3.1 and 6.3.2 are not exceeded when each of the following voltages is applied to each other measuring circuit TERMINAL, if applicable:

- highest RATED a.c. voltage at any RATED MAINS frequency;
- highest RATED d.c. voltage;
- highest RATED a.c. voltage at the *related* maximum RATED measurement frequency.

### 6.7.1.3 CREEPAGE DISTANCES

*Add the following new paragraph after the third paragraph:*

For HAND-HELD EQUIPMENT not powered from the MAINS or the measuring circuit, CREEPAGE DISTANCES according to material group I are allowed to be used for other materials.

For TERMINALS of HAND-HELD EQUIPMENT intended to be connected only to a HAND-HELD probe assembly complying with Part 031, CREEPAGE DISTANCES according to material group I are allowed to be used for the insulating material of the TERMINALS.

### 6.7.1.5 Requirements for insulation according to type of circuit

~~Addition:~~

~~Add the following new item ci) after item v) of the list of item e)~~

~~ci) — the circuit is a measuring circuit where MEASUREMENT CATEGORIES do not apply.~~

~~Add the following new item aa) to the list:~~

~~aa) in K.101 for measuring circuits of MEASUREMENT CATEGORIES II, III and IV.~~

~~Replacement:~~

~~Replace Note 2 with the following:~~

~~NOTE 2 — (Void)~~

*Replace the text with the following:*

Requirements for insulation in particular types of circuits are specified as follows:

- a) in 6.7.2 for MAINS CIRCUITS of OVERVOLTAGE CATEGORY II with a nominal supply voltage up to 300 V;

NOTE 1 See Annex I for nominal voltages of MAINS supplies.

- b) in 6.7.3 for secondary circuits separated from the circuits in a) only by means of a transformer;
- c) in Clause K.1 for MAINS CIRCUITS of OVERVOLTAGE CATEGORY III or IV or for OVERVOLTAGE CATEGORY II over 300 V;
- d) in Clause K.2 for secondary circuits separated from the circuits in c) only by means of a transformer;
- e) in Clause K.3 for circuits that have one or more of the following characteristics:
- 1) the maximum possible TRANSIENT OVERVOLTAGE is limited by the supply source or within the current sensor to a known level below the level assumed for the MAINS CIRCUIT;
  - 2) the maximum possible TRANSIENT OVERVOLTAGE is above the level assumed for the MAINS CIRCUIT;
  - 3) the WORKING VOLTAGE is the sum of voltages from more than one circuit, or is a mixed voltage;
  - 4) the WORKING VOLTAGE includes a recurring peak voltage that may include a periodic non-sinusoidal waveform or a non-periodic waveform that occurs with some regularity;
  - 5) the WORKING VOLTAGE has a frequency above 30 kHz;
  - 6) the circuit is a measuring circuit where MEASUREMENT CATEGORIES do not apply.
- f) in Clause K.101 for measuring circuits RATED for MEASUREMENT CATEGORIES

NOTE 2 These requirements are illustrated in the flowchart of Annex DD, Figure DD.1.

The TRANSIENT OVERVOLTAGE level for the MAINS corresponds to the "required RATED impulse voltage of equipment" value specified in Table 443.2 of IEC 60364-4-44:2007/AMD1:2015.

### 6.8.3.1 The a.c. voltage test

Replace the first sentence with the following sentence:

*The voltage tester shall be capable of maintaining the test voltage throughout the test within  $\pm 5\%$  of the specified value.*

## 6.9 Constructional requirements for protection against electric shock

Add the following two new subclauses:

### ~~6.9.101 Insulation requirements for JAWS and JAW ENDS~~

#### ~~6.9.101.1 Pre-treatment of the JAW ENDS~~

~~This pre-treatment shall be performed only for Type A and Type B current sensors RATED for MEASUREMENT CATEGORIES III and IV.~~

~~The pre-treatment is performed to simulate the wear of the JAWS during insertion and removal. It is not applicable to current sensors with a sliding JAW and to flexible current sensors.~~

~~Three samples of the current sensor in NORMAL CONDITION and three samples of the current sensor that have been conditioned as specified in 10.5.2 a) are treated as follows.~~

~~A pre-treatment plate is prepared consisting of a rigid material, covered on both sides by emery cloth. The pre-treatment plate is a minimum of 50 mm by 450 mm, with a thickness not exceeding 2 mm. The emery cloth shall be No. 120 grit, with aluminium oxide abrasive bound in an enclosed coating and with a cloth backing.~~

~~With the JAWS open, the current sensor is positioned as shown in Figure 102 and then the JAWS are closed.~~

~~The current sensor is moved along the pre-treatment plate a distance of 200 mm, or a lesser amount if restricted by the design, for 50 cycles—one cycle consisting of one forward and one reverse movement—so as to abrade the closing point of the JAWS (see Figure 102). If the insulation of the JAW ENDS has a wear indicator, the treatment is terminated if the wear indicator becomes visible before 50 cycles are completed. The emery cloth is replaced after each sample has been treated.~~

~~NOTE With regard to JAW ENDS, a wear indicator is a feature designed to be not visible until a limit of wear has been reached.~~

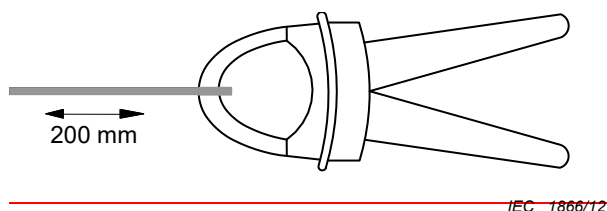


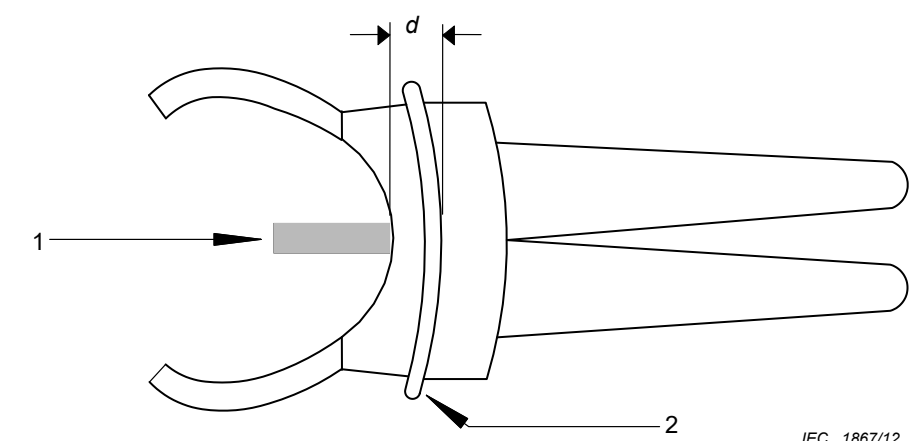
**Figure 102 — Pre-treatment of the JAW ENDS**

### ~~6.9.101.2 Protection against touching the HAZARDOUS LIVE conductor~~

~~To reduce the DANGER of the OPERATOR touching the HAZARDOUS LIVE conductor during clamping or measurement, Type A current sensors shall have a PROTECTIVE BARRIER or tactile indicator to warn the OPERATOR of the limit of safe access. The tactile indicator shall cover at least 50 % of the perimeter, and shall at least extend along two opposite sides of the HAND-HELD part.~~

~~The CLEARANCE and CREEPAGE DISTANCE between HAZARDOUS LIVE parts and the PROTECTIVE BARRIER or the tactile indicator shall meet the requirements for REINFORCED INSULATION for the RATING of the JAWS. Figure 103 gives an example of the CLEARANCE “d” from the PROTECTIVE BARRIER or tactile indicator to the JAWS and to the HAZARDOUS LIVE conductor.~~

~~Conformity is checked by inspection and measurement of CLEARANCES and CREEPAGE DISTANCES.~~



#### **Key**

1—HAZARDOUS LIVE conductor

2—PROTECTIVE BARRIER

d—Distance between PROTECTIVE BARRIER and HAZARDOUS LIVE conductor

**Figure 103 — CLEARANCE between the PROTECTIVE BARRIER or tactile indicator to the JAWS and to the HAZARDOUS LIVE conductor**

### ~~6.9.101.3 HAND-HELD or hand-manipulated parts~~

~~HAND-HELD or hand-manipulated parts of Type A current sensors shall be separated by DOUBLE INSULATION or REINFORCED INSULATION from the parts of the JAWS which can be touched by a metal test pin 100 mm long and 4 mm in diameter, in open and in closed position. If any conductive part of the magnetic circuit can touch a conductor, it is considered to be held at the RATED voltage to earth of the JAWS.~~

~~NOTE—The metal test pin simulates an UNINSULATED conductor.~~

~~If the wear indicator of a JAW END becomes visible during the pre-treatment, BASIC INSULATION is required for the JAW END after the pre-treatment.~~

~~Conformity is checked by inspection, by the determination of ACCESSIBLE parts according to 6.2, by measurement of CLEARANCES and CREEPAGE DISTANCES and by the tests of K.101.4 for solid insulation. If the JAW ENDS include a wear indicator, measurement and tests are done both before and after the pre-treatment of the JAW ENDS specified in 6.9.101.1, if applicable. If the JAW ENDS do not include a wear indicator, measurement and tests are performed after the pre-treatment.~~

#### **~~6.9.101.4 — Insulation of flexible current sensors~~**

~~Flexible cord used for the JAW of a flexible current sensor which has a wear indicator shall provide at least DOUBLE INSULATION or REINFORCED INSULATION when new, and at least BASIC INSULATION when the wear indicator is visible.~~

~~If the flexible cord has a wear indicator, it shall exhibit a contrasting colour when the limit of wear is reached.~~

~~Flexible cord used for the JAW of a flexible current sensor which does not have a wear indicator shall provide at least DOUBLE INSULATION or REINFORCED INSULATION when new and after typical lifetime wear.~~

~~Conformity is checked by the following tests:~~

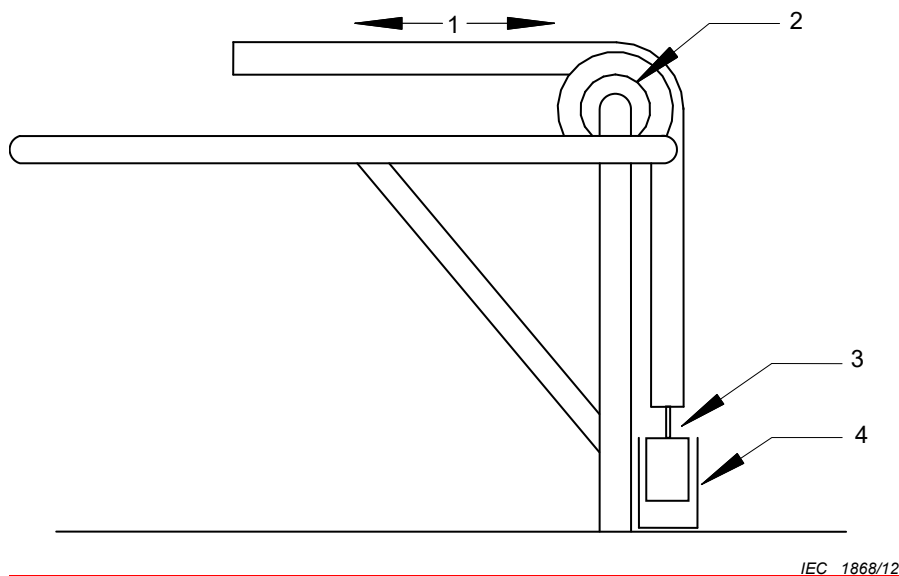
~~Three unconditioned samples of the flexible cord used for the JAW of the flexible current sensor and three samples conditioned as specified in 10.5.2 a) are tested. Each sample is 1 m long.~~

~~One unconditioned sample is checked as specified by K.101.4, with the values for REINFORCED INSULATION.~~

~~Each sample is passed over a piece of emery cloth mounted to and conforming with the pulley radius of curvature (see Figure 105), with the pulley fixed so that it cannot rotate (see Figure 104). The internal pulley diameter and the pulley radius of curvature are at least 5 times the cord diameter. The emery cloth shall be No. 120 grit, with aluminium oxide abrasive bound in an enclosed coating and a cloth backing. It shall be of sufficient length and width so that the sample makes contact with the emery cloth wherever it would otherwise contact the pulley surface. The emery cloth is replaced after each sample is treated. To prevent rolling of the flexible cord, the inside surface of the pulley is concave.~~

~~The flexible cord is placed over the pulley (see Figure 104) and supported by a 90° arc of the pulley. One end of the flexible cord is attached to a weight with a mass of 1 kg. The flexible cord is positioned so that its midpoint is at the centre of the emery cloth at the middle of the cycle. With the weight guided to prevent swinging, the flexible cord is passed over the emery cloth surface for the lesser of 15 cycles or until a wear indicator becomes visible — one cycle consisting of one forward and one reverse movement of the free end of the cord for a distance of 0,5 m.~~

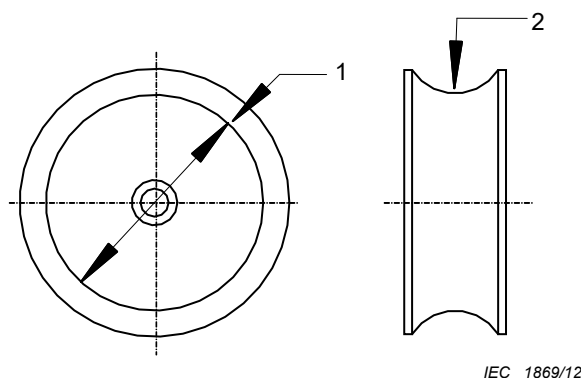
~~After this treatment, each sample is checked as specified by K.101.4. The voltage is applied between the internal conductors of the flexible cord and metal foil wrapped around the outer cord jacket. The BASIC INSULATION test voltage values are used if the cycling treatment was terminated because the contrasting colour became visible. The REINFORCED INSULATION test voltage values are used if 15 cycles were completed during the cycling treatment without the wear indicator becoming visible.~~



**Key**

- 1—Flexible-cord  
2—Fixed-pulley  
3—Weight  
4—Weight-guide

**Figure 104 — Treatment of the insulation of a flexible current sensor**



**Key**

- 1—Internal-pulley-diameter  
2—Pulley-radius-of-curvature

**Figure 105 — Pulley for the treatment of Figure 104**

**6.9.101.5 — Pull test for endcaps of flexible current sensors**

The endcaps of a flexible cord used for the JAW of the flexible current sensor shall be securely fixed, so that they withstand any forces likely to occur in NORMAL USE.

Conformity is checked by inspection and the following test on each endcap.

With the endcap clamped so that it cannot move, the flexible cord is subjected to a steady axial pull force according to Table 102 for 1 min.

After the pull the insulation shall not have moved more than 2 mm.

~~If the insulation has moved more than 2 mm, then the pull is repeated 15 more times with a duration of 15 s each.~~

~~After the last pull:~~

- ~~a) the insulation shall not have moved more than 1 mm more than the displacement from the first pull if it is subjected to 16 pulls;~~
- ~~b) CLEARANCES and CREEPAGE DISTANCES shall not have been reduced below the applicable values of K.101 for REINFORCED INSULATION; and~~
- ~~c) the current sensor shall pass the tests of K.101.4 for REINFORCED INSULATION.~~

**Table 102 – Pull forces for endcaps of flexible current sensors**

| Cross section area of the flexible cord<br>mm <sup>2</sup> | Pull force<br>N |
|------------------------------------------------------------|-----------------|
| ≤ 25                                                       | 50              |
| 100                                                        | 75              |
| ≥ 500                                                      | 100             |
| Linear interpolation is allowed.                           |                 |

#### **6.9.102 — Input measuring circuit leads**

~~Input measuring circuit leads and their accessories shall meet the requirements of IEC 61010-031, if applicable.~~

~~Conformity is checked by inspection.~~

#### **6.9.103 — Output circuit leads**

~~The output circuit leads of current sensors can easily touch HAZARDOUS LIVE parts of the installation under test. The output circuits of current sensors can also be held at a HAZARDOUS LIVE voltage when connected to a wattmeter, power quality analyser or similar equipment.~~

~~The output circuit leads of current sensors shall have REINFORCED INSULATION between their outer surfaces and their conductors.~~

~~The mated connectors and TERMINALS located at the current sensor ENCLOSURE body shall have REINFORCED INSULATION between their outer surfaces and their conductors.~~

~~For Type A, Type B and Type C current sensors, the insulation of the output circuit leads, and of the mated connectors and TERMINALS is based on the requirements of K.101 for the higher of the voltage RATING and the MEASUREMENT CATEGORY RATING of the JAWS or those RATINGS of the output circuit but not less than 300 V in MEASUREMENT CATEGORY II.~~

~~For Type D current sensors, the insulation of the output circuit leads and of the mated connectors and TERMINALS is based on the requirements of K.101 for 300 V in MEASUREMENT CATEGORY II.~~

~~Conformity is checked by inspection, by measurement of CLEARANCES and CREEPAGE DISTANCES and by the applicable tests of K.101.4 for solid insulation.~~

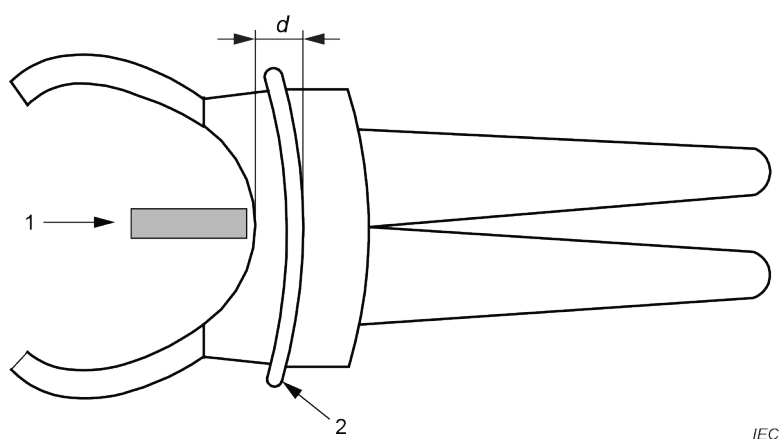
## 6.9.101 Protection against the HAZARDOUS LIVE conductor

### 6.9.101.1 Protection by a PROTECTIVE BARRIER

To reduce the RISK of the OPERATOR touching the HAZARDOUS LIVE conductor during clamping or measurement, Type A current sensors shall have a PROTECTIVE BARRIER to warn the OPERATOR of the limit of safe access. The PROTECTIVE BARRIER shall cover at least 50 % of the perimeter, and shall at least extend along two opposite sides of the HAND-HELD part.

The CLEARANCE and CREEPAGE DISTANCE between HAZARDOUS LIVE parts and the PROTECTIVE BARRIER shall meet the requirements for REINFORCED INSULATION for the RATING of the JAWS. Figure 102 gives an example of the CLEARANCE "d" from the PROTECTIVE BARRIER to the JAWS and to the HAZARDOUS LIVE conductor.

*Conformity is checked by inspection and measurement of CLEARANCES and CREEPAGE DISTANCES.*



#### Key

- 1 HAZARDOUS LIVE conductor
- 2 PROTECTIVE BARRIER
- d Distance between PROTECTIVE BARRIER and HAZARDOUS LIVE conductor

**Figure 102 – CLEARANCE between the PROTECTIVE BARRIER to the JAWS and to the HAZARDOUS LIVE conductor**

### 6.9.101.2 HAND-HELD or hand-manipulated parts

HAND-HELD or hand-manipulated parts of Type A current sensors shall be separated by DOUBLE INSULATION or REINFORCED INSULATION from the parts of the JAWS which can be touched by an UNINSULATED CONDUCTOR, in open and in closed position. If any conductive part of the magnetic circuit can touch a conductor, it is considered to be held at the RATED voltage to earth of the JAWS.

JAW ENDS which have a wear indicator shall provide at least DOUBLE INSULATION or REINFORCED INSULATION when new, and at least BASIC INSULATION when the wear indicator becomes visible.

*Conformity is checked by inspection, by determination of the touchable parts of the JAWS in open and in closed position using the metal pin of 6.2.3 and determination of the ACCESSIBLE HAND-HELD or hand-manipulated parts, and,*

- a) *if the current sensor is RATED for MEASUREMENT CATEGORIES, by measurement of the applicable values for CLEARANCES and CREEPAGE DISTANCES of K.101.2 and K.101.3, and for solid insulation by the applicable tests of K.101.4;*

- b) *if the current sensor is not RATED for MEASUREMENT CATEGORIES, by measurement of the applicable values for CLEARANCES and CREEPAGE DISTANCES of K.3.2 or K.3.3 and K.3.4, and for solid insulation by the applicable tests of K.3.5.*

*NOTE The metal test pin simulates an UNINSULATED CONDUCTOR.*

*In addition to the metal pin, the outer surfaces of the ENCLOSURE of the JAWS are covered with metal foil in open and in closed position during the test.*

*If the JAW ENDS of Type A current sensors RATED for MEASUREMENT CATEGORIES III and IV, include a wear indicator, measurement and tests are done both before and after the JAW ENDS abrasion test of 8.101 and the JAW impact test of 8.102, if applicable.*

*If the JAW ENDS do not include a wear indicator, measurement and tests are done after the JAW ENDS abrasion test of 8.101 and the JAW impact test of 8.102, if applicable.*

### **6.9.102 Input/output circuits**

Input/output circuits of Type A, Type B and Type C current sensors shall be separated by DOUBLE INSULATION or REINFORCED INSULATION from the parts of the JAWS which can be touched by an UNINSULATED CONDUCTOR, in open and in closed position. If any conductive part of the magnetic circuit can touch a conductor, it is considered to be held at the RATED voltage to earth of the JAWS.

JAW ENDS which have a wear indicator shall provide at least DOUBLE INSULATION or REINFORCED INSULATION when new, and at least BASIC INSULATION when the wear indicator becomes visible.

*Conformity is checked by inspection, by determination of the touchable parts of the JAWS in open and in closed position using the metal pin of 6.2.3, and,*

- a) *if the current sensor is RATED for MEASUREMENT CATEGORIES, by measurement of the applicable values for CLEARANCES and CREEPAGE DISTANCES of K.101.2 and K.101.3, and for solid insulation by the applicable tests of K.101.4;*
- b) *if the current sensor is not RATED for MEASUREMENT CATEGORIES, by measurement of the applicable values for CLEARANCES and CREEPAGE DISTANCES of K.3.2 or K.3.3 and K.3.4, and for solid insulation by the applicable tests of K.3.5.*

*NOTE The metal test pin simulates an UNINSULATED CONDUCTOR.*

*In addition to the metal pin, the outer surfaces of the ENCLOSURE of the JAWS are covered with metal foil in open and in closed position.*

*If the JAW ENDS include a wear indicator, measurement and tests are done both before and after the JAW ENDS abrasion test of 8.101 and the JAW impact test of 8.102, if applicable.*

*If the JAW ENDS do not include a wear indicator, measurement and tests are done after the JAW ENDS abrasion test of 8.101 and the JAW impact test of 8.102, if applicable.*

Add the following new subclause:

### **6.101 Output circuit leads**

#### **6.101.1 General**

The outer surfaces of output circuit leads of current sensors can easily touch HAZARDOUS LIVE parts of the installation under test. The inner conductors of output circuit leads of current sensors can also be held at a HAZARDOUS LIVE voltage when connected to measuring or control equipment (wattmeter, power quality analyser, etc.).

### 6.101.2 Connection to the current sensor ENCLOSURE body

The mated TERMINALS located at the current sensor ENCLOSURE body and/or the leads shall have DOUBLE INSULATION or REINFORCED INSULATION between their outer surfaces and their conductors.

For Type A, Type B and Type C current sensors, the insulation of the output circuit leads and the mated TERMINALS is based on the requirements of Clause K.101 for the higher of the voltage RATING and the MEASUREMENT CATEGORY RATING of the JAWS or this RATING of the output circuit but not less than 300 V in MEASUREMENT CATEGORY II.

For Type D current sensors, the insulation of the output circuit leads and of the mated TERMINALS is based on the requirements of Clause K.101 for 300 V in MEASUREMENT CATEGORY II.

*Conformity is checked by inspection, by measurement of the applicable values of CLEARANCES and CREEPAGE DISTANCES of K.101.2 and by the applicable tests of K.101.4 for solid insulation.*

### 6.101.3 Connection to measuring or control equipment

The manufacturer shall assign a voltage value and specify if a MEASUREMENT CATEGORY is RATED for this connection.

No minimum voltage RATINGS are required by this document for the current sensor TERMINALS dedicated for connection to measuring or control equipment.

The unmated TERMINALS shall comply with the requirements of 101.2.

If the current sensor has been designed for use only with a specific model of equipment, the current sensor TERMINAL RATING shall be consistent with the TERMINAL RATING of this specific measuring or control equipment.

*Conformity is checked as specified in 101.2, by inspection, and,*

- a) if the current sensor is RATED for MEASUREMENT CATEGORIES, by measurement of the applicable values for CLEARANCES and CREEPAGE DISTANCES of K.101.2 and K.101.3, and for solid insulation by the applicable tests of K.101.4;*
- b) if the current sensor is not RATED for MEASUREMENT CATEGORIES, by measurement of the applicable values for CLEARANCES and CREEPAGE DISTANCES of K.3.2 or K.3.3 and K.3.4, and for solid insulation by the applicable tests of K.3.5.*

## 7 Protection against mechanical HAZARDS

This clause of Part 1 is applicable.

## 8 Resistance to mechanical stresses

This clause of Part 1 is applicable except as follows:

### ~~8.1 — General~~

~~Addition:~~

~~Add the following new item 101), after item 3):~~

~~101) — for Type A current sensors RATED for MEASUREMENT CATEGORIES III and IV, the impact test of 8.2.101.~~

**8.2 — ENCLOSURE rigidity tests**

*Addition:*

*Add the following new subclause:*

**8.2.101 — JAW impact test**

~~The test is carried out on three samples of Type A current sensors RATED for MEASUREMENT CATEGORIES III and IV.~~

~~The current sensor is tested according to IEC 60068-2-75 by either test Eha (pendulum hammer) or test Ehc (vertical hammer) with an energy level of Table 103.~~

**Table 103 — Energy level**

| Current sensor mass<br>-kg | Energy level<br>J | IK Code<br>(IEC 62262) |
|----------------------------|-------------------|------------------------|
| $\leq 0,5$                 | 1                 | IK06                   |
| $> 0,5 \leq 1$             | 2                 | IK07                   |
| $> 1$                      | 5                 | IK08                   |

~~Current sensors are cooled to the minimum RATED ambient temperature, and then tested within 3 min. The current sensor is held firmly against a rigid support and opened as far as possible. Three points on the outer surfaces of the JAWS close to the JAW ENDS are tested on each sample. The number of impacts is one per point.~~

~~After the impact test, the current sensors are returned to a reference test temperature (see 4.3.1). For each voltage of Table 105 up to and including the highest RATED voltage of the JAWS, the specified test probe of Figure 106 and Table 105 is inserted into the JAW opening as shown in Figure 107. While each test probe is inserted, the current sensor shall pass the a.c. voltage test of 6.8.3.1 (without humidity preconditioning) with a duration of at least 1 min, or for current sensors RATED only for d.c., the 1 min d.c. voltage test of 6.8.3.2 (without humidity preconditioning), using the applicable test voltage of Table 105 applied between the test lead wires.~~

*Add the following four new subclauses:*

**8.101 JAW ENDS abrasion test**

When current sensors are applied to or removed from conductors, their JAW ENDS can be submitted to abrasion, in particular when the conductor is a busbar. These current sensors shall be designed to be safe after the following JAW ENDS abrasion test, performed to simulate the wear of the JAWS during insertion and removal. This requirement is applicable only to Type A and Type B current sensors RATED for MEASUREMENT CATEGORIES III and IV. Current sensors with a sliding JAW, current sensors with fork-style JAWS and flexible current sensors are not concerned by 8.101.

JAW ENDS can have a wear indicator to view the limit of use after abrasion. A wear indicator is a feature with a contrasting colour designed to be not visible until a limit has been reached.

One unconditioned sample of the current sensor in NORMAL CONDITION and one preconditioned sample of the current sensor that has been conditioned as specified in 10.5.2 a) are treated as follows.

A plate is prepared consisting of a rigid material, covered on both sides by emery cloth. The plate is a minimum of 50 mm by 450 mm, with a thickness not exceeding 2 mm. The emery cloth shall be No. 120 grit, with aluminium oxide abrasive bound in an enclosed coating and with a cloth backing.

With the JAWS open, the samples are positioned as shown in Figure 103 and then the JAWS are closed.

The samples are moved along the plate over a distance of 200 mm, or a lesser amount if restricted by the design, for 50 cycles – one cycle consisting of one forward and one reverse movement – so as to abrade the closing point of the JAWS (see Figure 103). If the insulation of the JAW ENDS has a wear indicator, the test is terminated if the wear indicator becomes visible before 50 cycles are completed. The emery cloth is replaced after each sample has been treated.

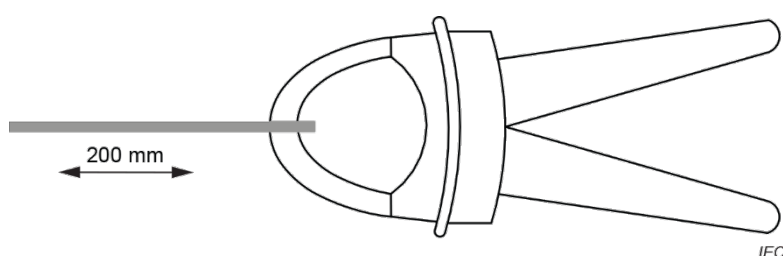


**Figure 103 – Abrasion test of the JAW ENDS**

After the abrasion test, the samples of current sensor are submitted to the conformity statement of 6.9.101.2 and 6.9.102.

### 8.102 Jaw impact test

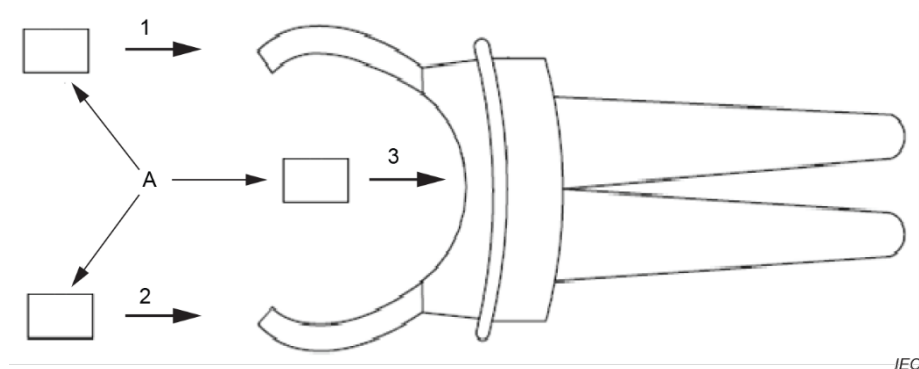
When current sensors are applied to or removed from conductors, they can hit them and be damaged, in particular when the conductor is a busbar. These current sensors shall be designed to be safe after the following JAW impact test, performed to simulate the stress of the JAWS during insertion. This requirement is applicable only to Type A current sensors RATED for MEASUREMENT CATEGORIES III and IV, except for flexible current sensors. The normal energy protection level required for impact is from Table 102.

The test is carried out on one sample of current sensor. The sample is tested according to IEC 60068-2-75 either by Eha (pendulum hammer) test, Ehb (spring hammer) test or Ehc (vertical hammer) test with an energy level determined from Table 102 according to the current sensor mass.

**Table 102 – Energy level for JAW impact test**

| Current sensor mass<br>kg | Energy level<br>J | IK code<br>(IEC 62262) |
|---------------------------|-------------------|------------------------|
| ≤ 0,5                     | 1                 | IK06                   |
| > 0,5 ≤ 1                 | 2                 | IK07                   |
| > 1                       | 5                 | IK08                   |

The sample is cooled to the minimum RATED ambient temperature for at least 4 h, and then tested within 3 min. The sample is held firmly against a rigid support and opened as far as possible. Three points are tested, two of these are on the outer surfaces of the JAWS close to the JAW ENDS, and the third point is the inner surface of the sensor directly opposite the opening (see Figure 104). The number of impacts is one per point.

**Key**

A Hammer

1, 2, 3 Direction of impact

**Figure 104 – Impact points for JAW impact test**

*After the JAW impact test, the sample of current sensor is returned to a reference test temperature (see 4.3.1) and submitted to the conformity statement of 6.9.101.2 and 6.9.102.*

**8.103 Pressure test at high temperature for insulation of flexible current sensors**

Flexible cords used for the JAW of a flexible current sensor shall not cause a HAZARD when subjected to mechanical stress likely to occur in NORMAL USE. To achieve this requirement, flexible cords shall be designed to be safe after the following pressure test, performed to simulate the stress of the flexible cords during use.

Flexible cords can have a wear indicator to view the limit of use. A wear indicator is a feature with a contrasting colour designed to be not visible until a limit of wear has been reached.

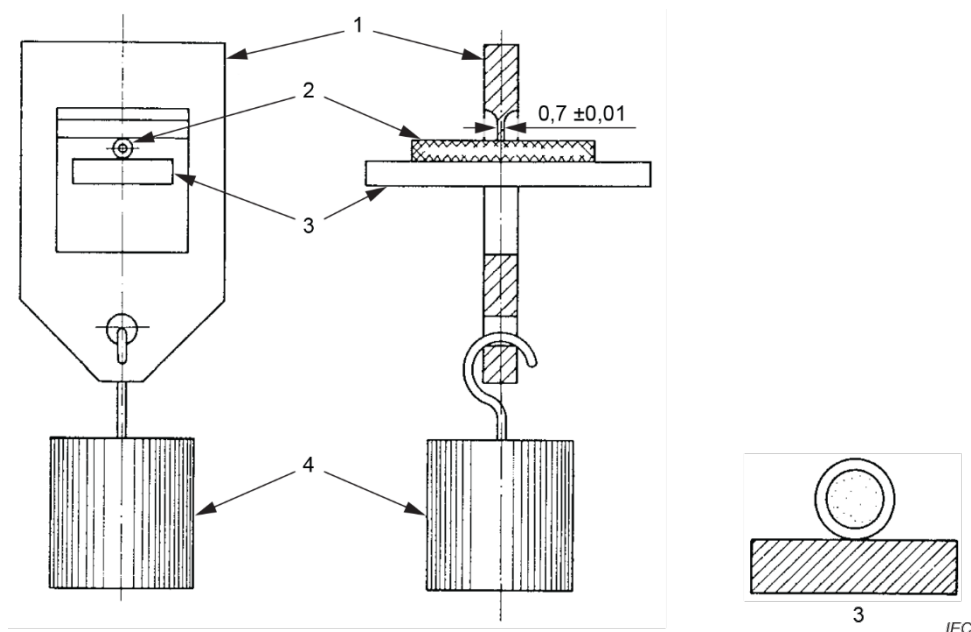
Flexible cords shall provide at least DOUBLE INSULATION or REINFORCED INSULATION when new. In addition, they shall meet the following:

- a) If they do not have a wear indicator, they shall provide at least DOUBLE INSULATION or REINFORCED INSULATION after typical lifetime wear.
- b) If they have a wear indicator, they shall provide at least BASIC INSULATION when the wear indicator becomes visible.

*Conformity is checked by the following tests:*

*Three samples of the flexible cord are tested. Each sample is taken from a flexible current sensor having a length of 150 mm to 300 mm. The length of each sample is 50 mm to 100 mm.*

*The indentation device is shown in Figure 105, and consists of a rectangular blade with an edge  $0,70\text{ mm} \pm 0,01\text{ mm}$  wide, which can be pressed against the sample. Each sample is placed in the position shown in Figure 105. A flat flexible cord without a sheath is laid on its flat side. Samples are fixed on the support in such a manner that they do not curve under the pressure of the blade. The force is applied in a direction perpendicular to the axis of the sample; the blade is also perpendicular to the axis of the sample.*



#### Key

- 1 Testing frame
- 2 Sample
- 3 Supports
- 4 Weight

**Figure 105 – Indentation device**

The compressing force  $F$  which is exerted by the blade upon the sample is given by the formula:

$$F = 0,6 \times \sqrt{(2 \times d \times e - e^2)}$$

where:

$F$  is in newtons

$e$  is the mean value of the thickness of the insulation of the sample

$d$  is the mean value of the outer diameter of the sample

$e$  and  $d$  are both expressed in millimetres, to one decimal place, and measured on a thin slice cut from the end of the test piece.

The test is carried out in air (i.e. in an air oven). The temperature of the air is maintained continuously at a temperature of minimum 105 °C. The loaded samples are kept in the test position for 4 h. Following this, the samples are rapidly cooled; cooling may be carried out by spraying the samples with cold water on the spot where the blade is pressing. The samples are removed from the apparatus when they have cooled to a temperature where recovery of the insulation no longer occurs. The samples are then cooled further by immersion in cold water.

After this treatment, each sample of flexible cord is checked as specified by the applicable tests of K.101.4 (without humidity preconditioning) if they are RATED for MEASUREMENT CATEGORIES, or by the applicable tests of K.3.5 (without humidity preconditioning) if they are not RATED for MEASUREMENT CATEGORIES.

*The voltage is applied between the internal conductors of the flexible cord and metal foil wrapped around the outer cord jacket. The BASIC INSULATION test voltage values are used if the contrasting colour of the wear indicator is visible. Otherwise, the REINFORCED INSULATION test voltage values are used.*

#### **8.104 Pull test for endcaps of flexible current sensors**

The endcaps of a flexible cord used for the JAW of the flexible current sensor shall be securely fixed, so that they withstand any forces likely to occur in NORMAL USE.

*Conformity is checked by inspection and the following test on each endcap.*

*With the endcap clamped so that it cannot move, the flexible cord is subjected to a steady axial pull force according to Table 103 for 1 min. After the pull, the insulation shall not have moved more than 2 mm. If the insulation has moved more than 2 mm, then the pull is repeated 15 more times with a duration of 15 s each time.*

*After the last pull:*

- a) the insulation shall not have moved more than 1 mm above the displacement from the first pull if it is subjected to 16 pulls;*
- b) CLEARANCES and CREEPAGE DISTANCES shall not have been reduced below the applicable values for REINFORCED INSULATION defined in K.101.2 and K.101.3 if the current sensor is RATED for MEASUREMENT CATEGORIES, or shall not have been reduced below the applicable values given in K.3.2 or K.3.3 and K.3.4 if the current sensor is not RATED for MEASUREMENT CATEGORIES; and*
- c) the current sensor shall pass the applicable tests for REINFORCED INSULATION defined in K.101.4 (without humidity preconditioning) if it is RATED for MEASUREMENT CATEGORIES, or the applicable tests of K.3.5 (without humidity preconditioning) if it is not RATED for MEASUREMENT CATEGORIES.*

**Table 103 – Pull forces for endcaps of flexible current sensors**

| Maximum diameter of the flexible cord | Pull force |
|---------------------------------------|------------|
| mm                                    | N          |
| ≤ 5                                   | 50         |
| 10                                    | 75         |
| ≥ 20                                  | 100        |
| Linear interpolation is allowed.      |            |

## **9 Protection against the spread of fire**

This clause of Part 1 is applicable.

## **10 Equipment temperature limits and resistance to heat**

This clause of Part 1 is applicable except as follows:

### **10.5 Resistance to heat**

*Add the following new subclause:*

### 10.5.101 Resistance to heat of current sensors

The insulating material of JAWS surrounding a magnetic material which can overheat shall have adequate resistance to heat.

*Conformity is checked by examination of material data. For rigid insulating materials, if the material data is not conclusive, one of the following tests is performed.*

- a) *A sample of the insulating material, at least 2,5 mm thick, is subjected to a ball-pressure test using the test apparatus in Figure 14. The test is made in a heating cabinet at the temperature measured as specified in  $10.101 \pm 2\text{ }^{\circ}\text{C}$ , or at  $105\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ , whichever is higher. The part to be tested is supported so that its upper surface is horizontal, and the spherical part of the apparatus is pressed against this surface with a force of 20 N. After 1 h the apparatus is removed and the sample is cooled within 10 s to approximately room temperature by immersion in cold water. The diameter of the impression caused by the ball shall not exceed 2 mm.*

*NOTE 1 If necessary, the required thickness can be obtained by using two or more sections of the part.*

*NOTE 2 See IEC 60695-10-2 for more information about this test.*

- b) *The Vicat softening test of ISO 306, method A120. The Vicat softening temperature shall be at least 105 °C.*

*Add the following new subclause:*

### 10.101 Other temperatures of current sensors

Most current sensors depend on inductive connection to the circuit being measured. The behaviour of the measuring circuit will, in these cases, depend on the frequency of the signal being measured. When the current sensor is used to measure currents at high frequency, circulating currents could cause significant heating within the magnetic circuit of the current sensor.

If a HAZARD could be caused by excessive temperature, easily touched surfaces shall not exceed the values of Table 19 and the temperature of the insulating material of windings shall not exceed the values of Table 20 when the current sensor measures the maximum current at the frequency which causes the highest temperature.

*NOTE The PROTECTIVE BARRIER of the current sensor (see 6.9.101.21) is not considered to provide a protection against burns.*

*Conformity is checked by measurement as specified in 10.4.*

## 11 Protection against HAZARDS from fluids and solid foreign objects

This clause of Part 1 is applicable.

## 12 Protection against radiation, including laser sources, and against sonic and ultrasonic pressure

This clause of Part 1 is applicable.

## 13 Protection against liberated gases and substances, explosion and implosion

This clause of Part 1 is applicable.

## 14 Components and subassemblies

This clause of Part 1 is applicable except as follows:

Add the following *two* new subclauses:

### 14.101 ~~Circuits or components used as to limit~~ TRANSIENT OVERVOLTAGE ~~limiting devices~~ in measuring circuits used to measure MAINS

If ~~control of~~ TRANSIENT OVERVOLTAGES ~~are limited~~ is employed in a measuring circuit used to measure MAINS, the overvoltage limiting ~~device~~ component or circuit shall have adequate strength to limit likely TRANSIENT OVERVOLTAGES ~~in NORMAL USE~~.

Conformity is checked by applying five positive and five negative impulses with the applicable impulse voltage of Table 104, spaced up to 1 min apart, from a hybrid impulse generator (see IEC 61180-4). The generator produces an open-circuit voltage waveform of  $1,2/50 \mu\text{s}$ , a short-circuit current waveform of  $8/20 \mu\text{s}$ , with an output impedance (peak open-circuit voltage divided by peak short-circuit current) of  $2 \Omega$  for MEASUREMENT CATEGORIES III and IV or  $12 \Omega$  for MEASUREMENT CATEGORY II. Resistance may be added in series if needed to raise the impedance. ~~The test impulse is applied in combination with the MAINS voltage. The MAINS voltage is the highest RATED voltage of the measuring circuit TERMINALS, but no more than 400 V a.c. r.m.s.~~

The test voltage is applied while the circuit is operating under conditions of NORMAL USE, in combination with the MAINS voltage between each pair of TERMINALS used to measure MAINS where voltage-limiting devices are present.

The MAINS voltage is the maximum RATED line-to-neutral voltage of the MAINS being measured. For measuring circuits RATED for MAINS line-to-neutral voltages above 400 V a.c. r.m.s. or d.c., the test may be performed with an available voltage source that has a line-to-neutral voltage of at least 400 V a.c. r.m.s. or d.c. The voltage source does not, in this case, need to match the measuring circuit RATING, but circuits RATED for a.c. shall be tested with an a.c. source, and circuits RATED for d.c. shall be tested with a d.c. source.

NOTE 1 The impulses are synchronized with the MAINS voltage phase, timed to occur at the peak of the MAINS voltage and to be of the same polarity, with a phase tolerance of  $\pm 10^\circ$  (see IEC 61180).

NOTE 2 This test can be extremely hazardous. Explosion shields and other provisions can be used to protect personnel performing the test.

No HAZARD shall arise ~~in the event that the component ruptures or overheats during the test. If a rupture occurs, no part of the component shall bridge safety-relevant insulation. If the component overheats, it shall not heat other materials to their self-ignition points.~~ The overvoltage limiting devices shall not rupture or overheat during the test. Tripping the circuit breaker of the MAINS installation is an indication of failure. If the results of the test are questionable or inconclusive, the test is to be repeated two more times.

**Table 104 – Impulse voltages**

| Nominal a.c. r.m.s. line-to-neutral or d.c. voltage of MAINS being measured<br><br>V | Impulse <del>withstand</del> voltage<br><br>V peak |                          |                         |
|--------------------------------------------------------------------------------------|----------------------------------------------------|--------------------------|-------------------------|
|                                                                                      | MEASUREMENT CATEGORY II                            | MEASUREMENT CATEGORY III | MEASUREMENT CATEGORY IV |
| ≤ 50                                                                                 | 500                                                | 800                      | 1 500                   |
| >50 ≤ 100                                                                            | 800                                                | 1 500                    | 2 500                   |
| > 100 ≤ 150                                                                          | 1 500                                              | 2 500                    | 4 000                   |
| > 150 ≤ 300                                                                          | 2 500                                              | 4 000                    | 6 000                   |
| > 300 ≤ 600                                                                          | 4 000                                              | 6 000                    | 8 000                   |
| > 600 ≤ 1 000                                                                        | 6 000                                              | 8 000                    | 12 000                  |
| > 1 000 ≤ 1 500                                                                      | 8 000                                              | 10 000                   | 15 000                  |
| >1 500 ≤ 2 000                                                                       | 12 000                                             | 15 000                   | 18 000                  |
| >2 000 ≤ 3 000                                                                       | 15 000                                             | 18 000                   | 20 000                  |
| Values over 1 000 V are from IEC TS 62993:2017, Table 1.                             |                                                    |                          |                         |

#### 14.102 Probe assemblies and accessories

Probe assemblies and accessories within the scope of IEC 61010-031, shall meet the requirements thereof.

*Conformity is checked by inspection.*

## 15 Protection by interlocks

This clause of Part 1 is applicable.

## 16 HAZARDS resulting from application

This clause of Part 1 is applicable ~~except as follows:~~

*Addition:*

*Add the following new subclause:*

#### ~~16.101 Reliance on the displayed value~~

##### ~~16.101.1 Over-range indication~~

~~If a HAZARD could arise from an OPERATOR'S reliance on the value displayed by the equipment, the display shall give an unambiguous indication whenever the value is above the maximum positive value or below the minimum negative value of the range to which the equipment is set.~~

~~NOTE Examples of ambiguous indications include the following, unless there is a separate unambiguous indication of an over-range value:~~

- ~~a) analogue METERS with stops at the exact ends of the range;~~
- ~~b) digital METERS which show a low value when the true value is above the range maximum (for example 1.001,5 A displayed as 001,5 A).~~

~~Conformity is checked by inspection and by provoking an over-range condition.~~

**~~16.101.2 Low battery indication~~**

~~When the battery of a current sensor which is powered by an internal battery, discharges, no HAZARD shall arise from an OPERATOR's reliance on a value displayed by the current sensor, at every battery voltage or energy level.~~

~~Conformity is checked by inspection and, in case of doubt, by provoking a battery discharge.~~

**17 Risk assessment**

This clause of Part 1 is applicable.

*Add the following new Clauses 101 and 102:*

**101 Measuring circuits****101.1 General**

The ~~equipment~~ current sensor shall provide protection against HAZARDS resulting from NORMAL USE and REASONABLY FORESEEABLE MISUSE of measuring circuits, as specified below.

- a) If a HAZARD could result, a current measuring circuit shall not interrupt the circuit being measured during range changing, or during the use of current sensors with an internal current transformer (see 101.2).
- b) An electrical quantity that is within specification for any TERMINAL shall not cause a HAZARD when it is applied to that TERMINAL or to any other compatible TERMINAL, with the range and function settings set in any possible manner (see 101.3).
- c) Any interconnection between the ~~equipment~~ current sensor and other devices or accessories intended to be used with the ~~equipment~~ current sensor shall not cause a HAZARD even if the documentation or markings prohibit the interconnection while the ~~equipment~~ current sensor is used for measurement purposes (see 6.6).
- d) A TEMPORARY OVERVOLTAGE or a TRANSIENT OVERVOLTAGE applied on the measuring circuits' TERMINALS in a voltage measurement function shall not cause a HAZARD (see 101.4).
- e) Other HAZARDS that could result from REASONABLY FORESEEABLE MISUSE shall be addressed by RISK assessment (see Clauses 16 and 17).

*Conformity is checked as specified in 6.6, Clause 16, Clause 17, 101.2, 101.3 and 101.4, as applicable.*

**101.2 Current sensor with an internal current transformer**

If a high voltage could be generated by an open-circuit condition of the output circuit, any voltage above the levels of 6.3.2 shall not be ACCESSIBLE.

*Conformity is checked by inspection of the output circuit TERMINALS or connector and, in case of doubt, by measurement of the output circuit voltage when the output circuit is interrupted while the current sensor is operating at the RATED current of the JAWS. The output circuit voltage is measured as specified in 6.3.2.*

**101.3 Protection against mismatches of inputs and ranges****101.3.1 General**

In NORMAL CONDITION and in cases of REASONABLY FORESEEABLE MISUSE, no HAZARD shall arise when the highest RATED voltage or current of a measuring circuit TERMINAL is applied to that TERMINAL or to any other compatible TERMINAL, with any combination of function and range settings.

NOTE Mismatches of inputs and ranges are examples of REASONABLY FORESEEABLE MISUSE, even if the documentation or markings prohibit such mismatch. A typical example is inadvertent connection of a high voltage to a measuring input intended for current or resistance. Possible HAZARDS include electric shock, burns, fire, arcing and explosion.

TERMINALS that are clearly not of similar types and that will not retain the connectors of the probe or accessory do not need to be tested and TERMINALS that can only be accessed by use of a TOOL do not need to meet the requirement of 101.3.1.

The ~~equipment~~ current sensor shall provide protection against these HAZARDS. One of the following techniques shall be used.

- a) Use of a certified overcurrent protection device to interrupt short-circuit currents before a HAZARD arises. In this case, the requirements and test of 101.3.2 apply.
- b) Use of an uncertified current limitation device, an impedance, or a combination of both to prevent the HAZARD from arising. In this case, the requirements and tests of 101.3.3 apply.

Conformity is checked by inspection, evaluation of the design of the ~~equipment~~ current sensor, and as specified in 101.3.2 and 101.3.3, as applicable.

~~These tests shall be performed with any probe assemblies supplied by the manufacturer, and repeated with the test leads of 101.3.4.~~

### 101.3.2 Protection by a certified overcurrent protection device

An overcurrent protection device is considered suitable if it is certified by an independent laboratory ~~to meet~~ and if all of the following requirements are met.

- a) The a.c. and d.c. RATED voltages of the overcurrent protection device shall be at least as high as, respectively, the highest a.c. and d.c. RATED voltages of any measuring circuit TERMINAL on the ~~equipment~~ current sensor.
- b) The RATED time-current characteristic (speed) of the overcurrent protection device shall be such that no HAZARD will result from any possible combination of RATED input voltages, TERMINALS, and range selection.

NOTE In practice, downstream circuit elements such as components and printed wiring board traces are selected to be able to withstand the energy that the overcurrent protection device will let through.

- c) The a.c. and d.c. RATED breaking capacities of the overcurrent protection device shall exceed, respectively, the possible a.c. and d.c. short-circuit currents.

The possible a.c. and d.c. short-circuit currents shall be calculated as the highest RATED voltages for any TERMINAL divided by the impedance of the overcurrent-protected measuring circuit, taking the impedance of the test leads specified in 101.3.4 into account.

For MEASUREMENT CATEGORIES II and III, the possible a.c. short-circuit current does not need ~~not~~ to exceed the applicable values of Table AA.1.

Additionally, spacings surrounding the overcurrent protection device in the ~~equipment~~ current sensor and following the protection device in the measuring circuit shall be sufficiently large to prevent arcing after the protection device opens.

Conformity is checked by inspection of the RATINGS of the overcurrent protection device and by the following test.

If the protection device is a fuse, it is replaced with an open-circuited fuse. If the protection device is a circuit-breaker, it is set to its open position. A voltage of two times the highest RATED voltage for any TERMINAL is applied to the TERMINALS of the overcurrent-protected measuring circuit for 1 min. ~~The test equipment shall be able to supply a current of at least 100 mA a.c. r.m.s. for voltages below 5 kV and a power of 500 VA at and above 5 kV. During and after the test, no damage to the equipment current sensor shall occur.~~

### 101.3.3 Protection by uncertified current limitation devices or by impedances

Devices used for current limitation shall be capable of safely withstanding, dissipating, or interrupting the energy that will ~~be applied as a result of short-circuit current~~ result from the application of the maximum RATED voltage of any compatible TERMINAL in NORMAL CONDITION and in the case of REASONABLY FORESEEABLE MISUSE.

An impedance used for limitation of current shall be one or more of the following.

- a) An appropriate single component which is constructed, selected, and tested so that safety and reliability for protection against relevant HAZARDS ~~is~~ are assured. In particular, the component shall
  - 1) be RATED for the maximum voltage that may be present in NORMAL CONDITION or during the REASONABLY FORESEEABLE MISUSE event;
  - 2) if a resistor, be RATED for twice the power or energy dissipation that may result in NORMAL CONDITION or from the REASONABLY FORESEEABLE MISUSE event;
  - 3) meet the applicable CLEARANCE and CREEPAGE DISTANCE requirements of Annex K for ~~REINFORCED~~ BASIC INSULATION between its terminations.
- b) A combination of components which shall:
  - 1) withstand the maximum voltage that may be present in NORMAL CONDITION or during the REASONABLY FORESEEABLE MISUSE event;
  - 2) be able to dissipate the power or energy that may result in NORMAL CONDITION or from the REASONABLY FORESEEABLE MISUSE event;
  - 3) meet the applicable CLEARANCE and CREEPAGE DISTANCE requirements of Annex K for ~~REINFORCED~~ BASIC INSULATION between the terminations of the combination of components.

NOTE 1 The CLEARANCES and CREEPAGE DISTANCES take into account the WORKING VOLTAGE across each insulation.

Conformity is checked by inspection and the following test, ~~repeated~~ performed three times on the same unit of ~~equipment~~ current sensor. If the test results in heating of any component, the ~~equipment~~ current sensor is allowed to cool before the test is repeated. If a device used for current limitation is damaged, it is replaced before the test is repeated.

The possible a.c. and d.c. short-circuit currents are calculated as the highest RATED voltage for any TERMINAL divided by the impedance of the current-limited measuring circuit, taking the impedance of the test leads specified in 101.3.4 into account. For MEASUREMENT CATEGORIES II and III, the possible a.c. short-circuit current should not exceed the values in Table AA.1.

A voltage equal to the highest RATED voltage for any TERMINAL is applied between the TERMINALS of the measuring circuit for 1 min. The source of the test voltage shall be able to deliver a current of at least the possible a.c. or d.c. short-circuit current as applicable. If the function or range controls have any effect on the electrical characteristics of the input circuit, the test is repeated with the function or range controls in every combination of positions, including during the change of function or range. During the test, the voltage output of the source is measured. If the source voltage decreases by more than 20 % for more than 10 ms, the test is considered inconclusive and is repeated with a lower impedance source.

During and after the test, no HAZARD shall arise, nor shall there be any evidence of fire, arcing, explosion, or damage to ~~impedance~~ current limitation devices, impedances or any component intended to provide protection against electric shock, heat, arc or fire, including the ENCLOSURE and traces on the printed wiring board. ~~Any damage to a device used for current limitation shall be ignored if other parts of the equipment were not affected during the test.~~

~~During the test, the voltage output of the source is measured. If the source voltage decreases by more than 20 % for more than 10 ms, the test is considered inconclusive and is repeated with a lower impedance source.~~

NOTE 2 This test can be extremely hazardous. Explosion shields and other provisions can be used to protect personnel performing the test.

#### 101.3.4 Test leads for the tests of 101.3.2 and 101.3.3

The tests of 101.3.2 and 101.3.3 shall be performed with ~~any~~ all test leads that are **included** specified or supplied by the manufacturer for use with the ~~equipment~~ current sensor and if the manufacturer has not specified the test leads, the tests shall be ~~repeated~~ performed with test leads that meet the following specifications:

- a) length = 1,0 m;
- b) cross section of the conductor = 1,5 mm<sup>2</sup>, stranded copper wire;

NOTE 1 A conductor with a 16 AWG (American Wire Gauge) cross section is acceptable.

- c) ~~equipment~~ connector compatible with the measuring circuit TERMINALS;
- d) connection to the test voltage source via a bare wire into suitable screw TERMINALS or thimble connectors (twist-on wire connectors) or equivalent means of providing a low-impedance connection;
- e) arranged as straight as possible.

NOTE 2 Test leads built to these specifications will have a d.c. resistance of about 15 mΩ each, or 30 mΩ per pair. For the purposes of calculation of possible fault current in 101.3.2 and 101.3.3, the value of 30 mΩ can be used for these test leads.

If the manufacturer-supplied test leads are permanently connected to the ~~equipment~~ current sensor, then the attached test leads supplied by the manufacturer shall be used without modification.

#### 101.4 Protection against MAINS overvoltages

~~MAINS voltage measuring circuits shall be so designed that, when a TEMPORARY OVERVOLTAGE or a TRANSIENT OVERVOLTAGE is applied on the measuring circuits TERMINALS in voltage measurement function in the proper range, no damage shall result which could cause a HAZARD.~~

~~MAINS voltage measuring circuits shall have a minimum of BASIC INSULATION between MAINS-connected conductive parts of opposite polarity.~~

~~Conformity is checked by inspection, and by the following impulse withstand voltage test using the applicable test voltage of Table 104, or by the impulse withstand voltage test of 14.101 if an overvoltage limiting component or circuit is used to control the TRANSIENT OVERVOLTAGE.~~

~~The test voltage is applied between each pair of TERMINALS used to measure MAINS voltage. The impulse withstand voltage test shall be conducted for five impulses of each polarity with an interval of at least 1 s between impulses. The impulse voltage test is carried out with a 1,2/50 μs waveform (see Figure 1 of IEC 61180 1:1992). The wave shape of each impulse shall be observed (see Note 1 below).~~

To ensure protection against arc flash or fire, measuring circuits RATED for measuring MAINS voltages shall have minimum CLEARANCES and CREEPAGE DISTANCES equivalent to BASIC INSULATION between MAINS-connected conductive parts of opposite polarity.

Conformity is checked by inspection and measurement.

In addition, the measuring circuit TERMINALS of a voltage measuring circuit that are RATED for MEASUREMENT CATEGORIES III or IV shall withstand the applicable TRANSIENT OVERVOLTAGE with the voltage measurement function selectors set for the proper function and range, without damage which could cause a HAZARD.

*Conformity is checked by the following impulse voltage test using the applicable impulse voltage of Table 104.*

*The impulse voltage is applied between each pair of TERMINALS RATED for MEASUREMENT CATEGORY III or IV. The impulse voltage test shall be conducted for five impulses of each polarity spaced up to 1 min apart, from a hybrid impulse generator (see IEC 61180). The generator produces an open-circuit voltage waveform of 1,2/50  $\mu$ s, a short-circuit current waveform of 8/20  $\mu$ s, with an output impedance (peak open-circuit voltage divided by peak short-circuit current) of 2  $\Omega$  for MEASUREMENT CATEGORIES III and IV. Resistance may be added in series if needed to raise the impedance.*

*The impulse voltage is applied while the circuit is working under conditions of NORMAL USE, in combination with the MAINS voltage.*

*The MAINS voltage used for the test is the maximum RATED line-to-neutral voltage of the MAINS being measured. For measuring circuits RATED for MAINS line-to-neutral voltages above 400 V a.c. r.m.s. or d.c., the test may be performed with an available MAINS voltage source that has a line-to-neutral voltage of at least 400 V a.c. r.m.s. or d.c. The MAINS voltage source does not, in this case, need to match the measuring circuit RATING, but circuits RATED for a.c. or a.c. plus d.c. shall be tested with an a.c. source, and circuits RATED for d.c. only shall be tested with a d.c. source.*

*NOTE 1 The impulses are synchronized with the MAINS voltage phase, timed to occur at the peak of the MAINS voltage, and to be of the same polarity, with a phase tolerance of  $\pm 10^\circ$  (see IEC 61180).*

*NOTE 2 This test can be extremely hazardous. Explosion shields and other provisions can be used to protect personnel performing the test.*

*When verifying CLEARANCES within ~~equipment~~ the current sensor by an impulse voltage test, it is necessary to ensure that the specified impulse voltage appears at the CLEARANCE.*

*The wave shape of each impulse shall be observed (see Note 3). Distortions of the impulse voltage which do not change from impulse to impulse may be caused by operation of an overvoltage limiting device and do not indicate a (partial) breakdown of solid insulation.*

*No HAZARD shall arise. No flashover of CLEARANCES or breakdown of solid insulation shall occur during the test, but partial discharges are allowed. Partial discharge will be indicated by a step in the resulting wave shape which will occur earlier in successive impulses. Breakdown on the first impulse may either indicate a complete failure of the insulation system or the operation of overvoltage limiting devices in the ~~equipment~~ current sensors. If overvoltage limiting devices are present, they shall not rupture or overheat during the test. Tripping the circuit breaker of the MAINS installation is an indication of failure. If the results of the test are questionable or inconclusive, the test is to be repeated two more times.*

~~NOTE 1 Distortions of the impulse voltage which do not change from impulse to impulse can be caused by operation of an overvoltage limiting device and do not indicate a (partial) breakdown of solid insulation.~~

~~NOTE 2~~ 3 Partial discharges in voids can lead to partial notches of extremely short durations in the wave shape which can be repeated in the course of an impulse.

## 102 Prevention of HAZARD from arc flash and short-circuits

### 102.1 General

When a current sensor temporarily bridges two high-energy conductors, it may cause a short-circuit, resulting in high current flow through the current sensor. The current sensor may

become hot, or may melt. This may cause burns to an OPERATOR or a bystander near the current sensor.

If contact is broken (by OPERATOR action, melting, or other event) while current is flowing through the current sensor, arcing may occur. The arcing will ionize the air in the vicinity of the arc, permitting continued current flow in the vicinity of the current sensor. If there is sufficient available energy, then the ionization of the air will continue to spread and the flow of current through the air continues to increase. The result is an arc flash, which is similar to an explosion, and can cause injury or death to an OPERATOR or a bystander.

The current sensor shall be constructed to mitigate the RISK of arc flash and short-circuits.

*Conformity is checked as specified in 102.2 and 102.3. All measurements and tests of 102.2 and 102.3 are done after ~~the pre-treatment of~~ the JAW ENDS ~~specified in 6.9.101.1~~ abrasion test of 8.101, if applicable.*

## 102.2 Protection against short-circuits during clamping

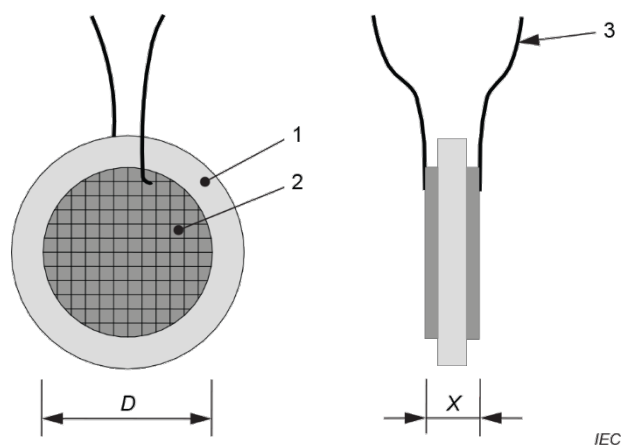
Type A and Type B current sensors shall have additional protection against a short-circuit caused by the JAWS during insertion and removal between conductors and between busbars. *This requirement is not applicable to Type A current sensors with fork-style JAWS which do not clamp the conductors or the busbars.*

NOTE Examples of protective measures are shrouds, PROTECTIVE BARRIERS, covers, or distances on the opposite sides of the JAW ENDS.

For the purposes of this document, it is assumed that a single JAW END is not able to short-circuit two separated conductors in an electric installation. The maximum voltage between two UNINSULATED CONDUCTORS which could be short-circuited during clamping is considered to be ~~the~~ equal to or lower than the line-to-line voltage of the distribution system for which the current sensor is RATED.

*Conformity is checked by inspection and, if applicable, by the a.c. test of 6.8.3.1 with a duration of at least 1 min or, for d.c. ~~conductors~~ current sensors, the 1 min d.c. test of 6.8.3.2 using the test voltages from Table 105 applied between the test lead wires for each voltage of Table 105 up to and including the highest RATED voltage of the JAWS, while each specified test probe of Figure 106 and of Table 105 for the considered voltage is inserted into the JAW opening as shown in Figure 107.*

*EXAMPLE If the RATED voltage of the JAWS is 450 V, then the tests ~~will be~~ are performed with a 6 mm probe, a 10 mm probe, and a 15 mm probe.*



**Key**

- 1 Non-conductive base material
- 2 Conductive surface material
- 3 Test lead wires
- $D$  Diameter of conductive surface material
- $X$  Overall thickness of test probe

**Figure 106 – Test probe to check protection against short-circuits**

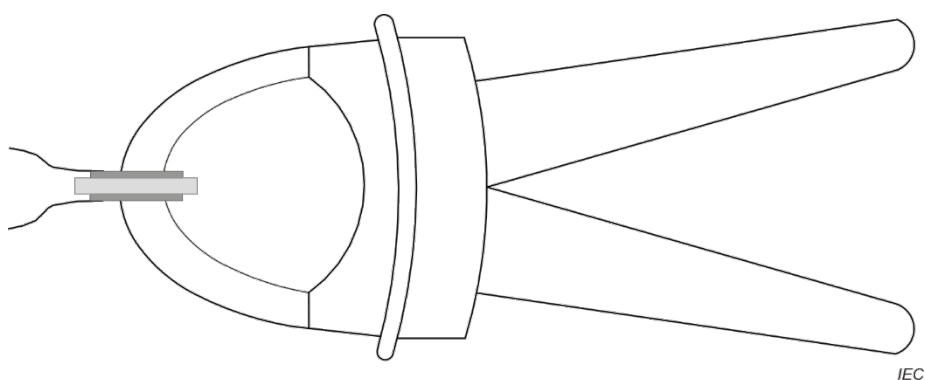


**Figure 107 – Use of the test probe of Figure 106**

**Table 105 – Thickness of the test probe of Figure 106 and test voltages**

| RATED a.c. r.m.s. or d.c.<br>voltage of the JAWS<br><br>V                                                                                                                                                                                                                               | Thickness X<br>of the test probe <sup>a</sup><br><br>mm | Test voltage <sup>b</sup>       |                               |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------|---------------------------------|-------------------------------|
|                                                                                                                                                                                                                                                                                         |                                                         | 1 min a.c. test<br><br>V r.m.s. | 1 min d.c. test<br><br>V d.c. |
| ≤ 150                                                                                                                                                                                                                                                                                   | 6                                                       | 350                             | <del>450</del> 500            |
| > 150 ≤ 300                                                                                                                                                                                                                                                                             | 10                                                      | 650                             | <del>900</del> 920            |
| > 300 ≤ 600                                                                                                                                                                                                                                                                             | 15                                                      | 1 300                           | 1 850                         |
| > 600 ≤ 1 000                                                                                                                                                                                                                                                                           | 25                                                      | 2 200                           | 3 100                         |
| > 1 000 ≤ 1 500                                                                                                                                                                                                                                                                         | 25                                                      | 3 000                           | 4 250                         |
| > 1 500 ≤ 2 000                                                                                                                                                                                                                                                                         | 25                                                      | 3 750                           | 5 300                         |
| > 2 000 ≤ 3 000                                                                                                                                                                                                                                                                         | 25                                                      | 5 250                           | 7 400                         |
| <sup>a</sup> If the JAWS do not open to the appropriate dimension, the probe thickness will equal the maximum JAW opening.<br><sup>b</sup> The values for the test voltage apply to tests performed at 2 000 m. For other test site altitudes, the corrections of Table 10 are applied. |                                                         |                                 |                               |

### 102.3 Protection against short-circuits in closed position

In closed position, JAWS of Type A, Type B, and Type C current sensors shall have BASIC INSULATION between the outer surface of the ENCLOSURE of the JAWS and all conductive parts including small metal parts such as screws or rivets, except the JAW ENDS. This requirement is also applicable to Type A current sensors with fork-style JAWS, by assimilating the rigid ENCLOSURE of the JAWS without the JAW ENDS being in a closed position.

Conductive parts of the JAW ENDS shall not be ACCESSIBLE in closed position.

*Conformity is checked by inspection, by the tests of K.101.4 for solid insulation and by the determination of whether the JAW ENDS are ACCESSIBLE in closed position in accordance with 6.2. For the voltage tests, insulated outer surfaces of the ENCLOSURE of the JAWS are covered with metal foil everywhere except around the JAW ENDS. The distance from the foil to the JAW ENDS is the applicable CLEARANCE.*

## Annexes

All annexes of Part 1 are applicable except as follows.

### Annex D (normative)

#### Parts between which insulation requirements are specified (see 6.4 and 6.5.3)

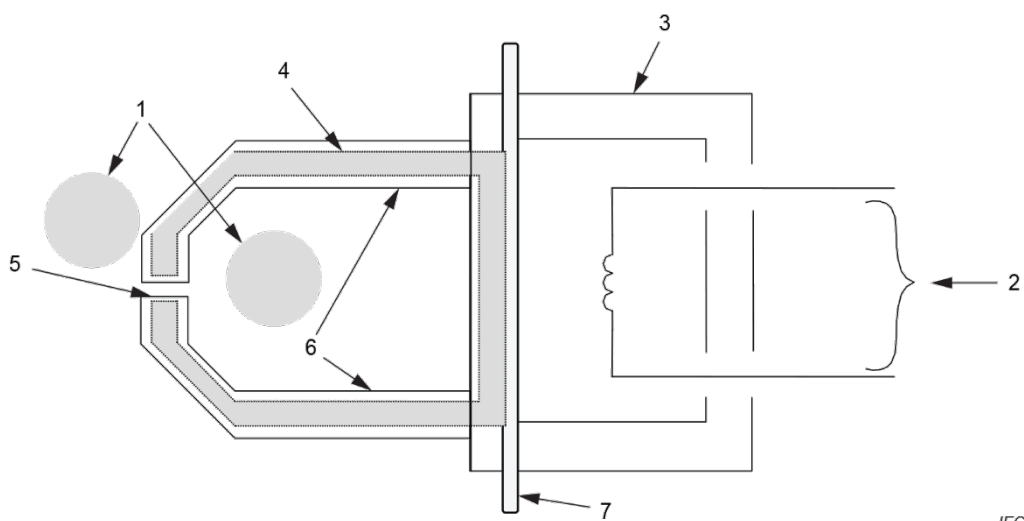
Replace the title of Annex D with the following title:

### Annex D (normative)

#### Parts between which insulation requirements are specified (see 6.4, 6.5.3, 6.9.101 and ~~6.9.103~~ 6.101)

Add the following new paragraph, figure and table at the end of Annex D.

Figure D.101 and Table D.101 show parts of current sensors between which insulation is required as specified.



#### Key

- |   |                                                                       |   |                                     |
|---|-----------------------------------------------------------------------|---|-------------------------------------|
| 1 | HAZARDOUS LIVE UNINSULATED CONDUCTOR within the JAWS or near the JAWS | 3 | HAND-HELD or hand-manipulated parts |
| 2 | Input/output circuit                                                  | 5 | JAW END                             |
| 4 | Magnetic circuit                                                      | 7 | PROTECTIVE BARRIER                  |
| 6 | JAW ENCLOSURE                                                         |   |                                     |

Figure D.101 – Parts of current sensors (see also Table D.101)

**Table D.101 – Insulation requirements ~~between circuits and~~  
ACCESSIBLE parts of for current sensors**

| Current sensor                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Insulation between parts |         |                      |                      |         |                      |         |         |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|---------|----------------------|----------------------|---------|----------------------|---------|---------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 1 and 2                  | 1 and 3 | 1 and 4 <sup>a</sup> | 2 and 3 <sup>b</sup> | 2 and 5 | 2 and 6 <sup>b</sup> | 3 and 5 | 4 and 6 |
| Type A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | D                        | D       | B                    | D                    | D       | D                    | D       | B       |
| Type B                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | D                        | -       | B                    | D                    | D       | D                    | -       | B       |
| Type C                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | D                        | -       | B                    | D                    | -       | D                    | -       | B       |
| Type D                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | NA                       | NA      | NA                   | D                    | B       | D                    | -       | -       |
| <p>Numbers in the second row refer to those of Figure D.101 parts.</p> <p>The following symbols are used to indicate:</p> <ul style="list-style-type: none"> <li>- no requirement</li> <li>B BASIC INSULATION is required</li> <li>D DOUBLE INSULATION or REINFORCED INSULATION is required</li> <li>NA not applicable</li> </ul> <p><sup>a</sup> Only in closed position.</p> <p><sup>b</sup> Parts 3 and 6 are parts of the current sensor ENCLOSURE (see also Figures D.2 c) and D.2 d)).</p> |                          |         |                      |                      |         |                      |         |         |

## Annex F (normative)

### Routine tests

#### F.1 General

Replace the first sentence with the following text:

The manufacturer shall perform the tests of Clauses F.2 to F.4 and Clause F.101 on 100 % of ~~equipment~~ the current sensors produced that ~~has~~ have both HAZARDOUS LIVE parts and ACCESSIBLE conductive parts.

Add the following new clause:

#### F.101 JAWS of current sensors

For Type A, Type B, and Type C current sensors, a test voltage for BASIC INSULATION is applied between:

- exposed conductive parts of the JAWS or JAW ENDS, and
- ACCESSIBLE conductive parts within the HAND-HELD or hand-manipulated area and input and output circuits connected together.

Type D current sensors and other current sensors whose JAWS and JAW ENDS do not have ACCESSIBLE conductive parts do not need to be subjected to this test.

The test voltage may be a.c. using the applicable test voltage of Table K.102, d.c. or impulse, ~~and is selected from Table F.101~~ using the applicable test voltage of Table K.103, for the appropriate MEASUREMENT CATEGORY. The d.c. test voltage value is equal to 1,414 the a.c. test voltage value. For the a.c. and d.c. tests, the test voltage is raised to its specified value within 5 s, and maintained for at least 2 s. Impulse tests are the 1,2/50  $\mu$ s test specified in IEC 61180 conducted for a minimum of three pulses of each polarity at 1 s minimum intervals. For current sensors ~~with no~~ not RATED for MEASUREMENT CATEGORY, the value of the test voltage is 1,5 times the RATED voltage to earth of the JAWS but not less than 350 V a.c. r.m.s. or 500 V d.c.

No flashover of CLEARANCES or breakdown of solid insulation shall occur during the test.

**Table F.101 — Test voltages for ROUTINE TESTS of JAWS of current sensors**

| RATED a.c.<br>r.m.s. or d.c.<br>voltage to earth<br>of the JAWS<br><br>V | MEASUREMENT CATEGORY II          |                                |                                         | MEASUREMENT CATEGORY III         |                                |                                         | MEASUREMENT CATEGORY IV          |                                |                                         |
|--------------------------------------------------------------------------|----------------------------------|--------------------------------|-----------------------------------------|----------------------------------|--------------------------------|-----------------------------------------|----------------------------------|--------------------------------|-----------------------------------------|
|                                                                          | 2 s a.c.<br>test<br><br>V r.m.s. | 2 s d.c.<br>test<br><br>V d.c. | 1,2/50 $\mu$ s<br>impulse<br><br>V peak | 2 s a.c.<br>test<br><br>V r.m.s. | 2 s d.c.<br>test<br><br>V d.c. | 1,2/50 $\mu$ s<br>impulse<br><br>V peak | 2 s a.c.<br>test<br><br>V r.m.s. | 2 s d.c.<br>test<br><br>V d.c. | 1,2/50 $\mu$ s<br>impulse<br><br>V peak |
| $\leq 150$                                                               | 840                              | 1 200                          | 1 200                                   | 1 400                            | 2 000                          | 2 000                                   | 2 200                            | 3 100                          | 3 100                                   |
| $> 150 \leq 300$                                                         | 1 400                            | 2 000                          | 2 000                                   | 2 200                            | 3 100                          | 3 100                                   | 3 300                            | 4 700                          | 4 700                                   |
| $> 300 \leq 600$                                                         | 2 200                            | 3 100                          | 3 100                                   | 3 300                            | 4 700                          | 4 700                                   | 4 300                            | 6 000                          | 6 000                                   |
| $> 600 \leq 1 000$                                                       | 3 300                            | 4 700                          | 4 700                                   | 4 300                            | 6 000                          | 6 000                                   | 5 300                            | 7 500                          | 7 500                                   |

## Annex K (normative)

### Insulation requirements not covered by 6.7

#### K.3 Insulation in circuits not addressed in 6.7, Clause K.1 or Clause K.2

Replace the *existing* title of Clause K.3 with the following:

#### K.3 Insulation for circuits not addressed in 6.7, Clauses K.1, K.2 or K.101 and for measuring circuits where MEASUREMENT CATEGORIES do not apply

##### K.3.1 General

*Addition:*

*Add the following new item aa) to the list*

~~aa) — the circuit is a measuring circuit where MEASUREMENT CATEGORIES do not apply.~~

*Replacement:*

~~Replace the second paragraph with the following:~~

~~In cases a) to c) and aa), CLEARANCES for BASIC INSULATION and SUPPLEMENTARY INSULATION are determined according to K.3.2.~~

*Deletion:*

~~Delete the note.~~

*Addition:*

*Replace the text with the following:*

These circuits have one or more of the following characteristics:

- a) the maximum possible TRANSIENT OVERVOLTAGE is limited by the supply source or within the current sensor (see Clause K.4.) to a known level below the level assumed for the MAINS CIRCUIT;
- b) the maximum possible TRANSIENT OVERVOLTAGE is above the level assumed for the MAINS CIRCUIT;
- c) the WORKING VOLTAGE is the sum of voltages from more than one circuit, or is a mixed voltage;
- d) the WORKING VOLTAGE includes a recurring peak voltage that may include a periodic non-sinusoidal waveform or a non-periodic waveform that occurs with some regularity;
- e) the WORKING VOLTAGE has a frequency above 30 kHz;
- f) the circuit is a measuring circuit where MEASUREMENT CATEGORIES do not apply.

In cases a) to c) and f), CLEARANCES for BASIC INSULATION and SUPPLEMENTARY INSULATION are determined according to K.3.2.

In cases d) and e) CLEARANCES are determined according to K.3.3.